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*Otis, G. A. 1875.*

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REPORT

ON A PLAN FOR

TRANSPORTING WOUNDED SOLDIERS

BY

RAILWAY IN TIME OF WAR;

WITH DESCRIPTIONS OF VARIOUS METHODS EMPLOYED  
FOR THIS PURPOSE ON DIFFERENT OCCASIONS.



BY GEORGE A. OTIS,  
ASSISTANT SURGEON, U. S. ARMY.

WASHINGTON:  
WAR DEPARTMENT,  
SURGEON GENERAL'S OFFICE.  
1875.



Compliments of  
George A. Otis.

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1875, Oct. 26.  
Gift of  
Samuel R. Allen, M.D.  
of Boston.  
(25.11.1851.)



A  
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TRANSPORTING WOUNDED SOLDIERS  
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RAILWAY IN TIME OF WAR; ETC.

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GENERAL: I have the honor to report, in obedience to your instructions, on the plan proposed by the Russian engineer, Mr. A. Zavodovsky, for the railway transportation of the sick and wounded in time of war.

The pamphlet with its accompanying documents, transmitted through the State Department, gives a concise but lucid explanation of the proposed plan, and is accompanied by drawings illustrating its practical application.\* The official correspondence on the subject, and a translation of Mr. Zavodovsky's paper, with reduced copies of the lithographed plates that illustrate it, are appended to this report.

Recent wars have exemplified the great influence of the direction of railroad lines upon the plans and strategic arrangements of military commanders; and, undoubtedly, in future campaigns this factor will become yet more important. The immense development of trunk lines and interlacing networks of railway in all civilized countries affords such opportunities for the transport and rapid concentration of men, munitions and stores, that, beyond question, this auxiliary will, hereafter, be more and more valued.

As the facilities afforded by railroad transport for the movement of troops and material to the theatre of warfare formidably augment the destructive power of armies, they also offer a useful and most effective means of saving lives

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\*ZAVODOVSKY (A.) *Transport Spécial des Malades et des Blessés en Temps de Guerre, par Voies Ferrées*, St. Petersburg, 1874.

and alleviating suffering, by the speedy removal of the sick and wounded from the scene of active operations. As it behooves the medical staff that, with every advance in the art of destroying men, as Louis termed it, methodically and gloriously, there should be corresponding improvement in the art of saving life and diminishing pain, the great advantages offered by railroads for disencumbering the active force of its disabled men, by conveying the latter to points where the best hospital accommodation can be enjoyed undisturbed, were not likely to pass unobserved by those charged with the administration of the medical service of armies; and we shall presently see that they hastened to avail of these new facilities. The proposition of Mr. Zavodovsky is therefore, in one sense, not a novelty. It is to be compared with various other systems proposed to fulfil the same object, with a view of determining whether it attains its end with greater simplicity, convenience, economy, and regard to the comfort of the disabled, than is accomplished by other methods.

While it is held by some military surgeons that certain of the severely wounded, as those with penetrating wounds of the great cavities, and of the large joints, and with shot fractures of the femur, should be regarded, with their attendants, as neutrals, and treated as near as practicable to the spot where they fall, yet no one questions the advantages of speedy removal, or, as the French say, *evacuation*, of the great bulk of sick and wounded from the theatre of hostilities.

By rapid dispersion of the disabled, the fighting force is less diminished than by any other plan. Fewer combatants are withdrawn from their proper duties to attend their sick and wounded comrades. With proper inspection of those sent to the rear, and such enforcement of discipline in the base hospitals as will ensure the prompt return of convalescents, the number of sick and wounded engaging in fresh active service will be greater than by any other arrangement; and a less proportion of division, brigade, and regimental medical officers and hospital attendants need be detached from the marching columns; which, in the exigencies of actual battle, are rarely adequately supplied with surgical assistance. Large accumulations of medical and hospital supplies with the army become superfluous. The *depôt* hospitals, frequently great lurking places for malingerers, may be reduced to the smallest compass. If, without changes, the wounded can be directly placed in a fixed hospital not too distant, many primary mutilations may be justifiably avoided, with a view of employing more delicate special operations when the patients arrive at a safe place of rest. Lastly, the most important consideration is the most obvious, the distribution of the sick and wounded prevents the generation of those pestilences that are the greatest scourge of armies. The sick and wounded avoid infecting each other, and those who are well escape contagion.

The Italian war of 1859 was the first in which transportation of the sick and wounded by railroads was extensively employed. The Austrian, French

and Sardinian armies availed of this resource; yet, after the carnage at Solferino, the hospitals at Milan, Brescia, Pavia, and Turin were frightfully overcrowded. Baron Hippolyte Larrey, who accompanied the French Emperor as Physician-in-Chief, in an address before the Academy of Medicine of Paris, boasted of "the rapid intervention of the railways, by which the work of evacuation of the wounded was achieved."\* But he did not state what arrangements, if any, were made to adapt the cars to the special service required; and, it would appear that the passenger trains were used, for the most part, without alterations.

The first published proposition to suspend litters in freight cars, as the means best calculated for the rapid transit of sick and wounded, while providing for the concussions caused by the swaying and jarring of these vehicles, the first, at least, that I have met, emanated from Dr. E. Gurlt, now a celebrated professor of military surgery at Berlin. In 1859 Dr. Gurlt† submitted a project for carrying the wounded in hammocks, suspended to the panels of freight cars by iron hooks. A commission was appointed by the Prussian Government to test the feasibility of this system. An adverse report was made. It was found in practice that the roofs of the freight cars would not sustain the weight of the loaded cots; the screws drew out, and the hooks and hammocks fell. Moreover, the swaying movement of the hammocks induced vertigo, or led to collisions. After repeated experiments, the commission recommended, in 1860, that the floors of the freight cars should be thickly covered with straw, and that the severely wounded should be carried to the trains on straw mattresses furnished on either side with three strong loops of webbing, through which stretcher poles or lance staffs could be passed to constitute a sort of stretcher. The mattresses were laid directly upon the loose straw.‡ This mode of transport was adopted on a large scale by the Prussian army in the Danish war, and in the Silesian or Six Weeks War of 1866.

\* LARREY (H.) *Discussion sur la Salubrité des Hôpitaux*, in *Bulletin de l'Acad. de Méd.* T. XXVII, 1861-2, p. 464: "Si les brancards, les cacolets et les voitures d'ambulance nous ont parfois manqué, nous avons trouvé partout le dévouement ingénieux qui invente et multiplie les ressources, jusqu'à ce que l'intervention rapide des chemins de fer et des bateaux à vapeur eût garanti complètement et achevé l'œuvre des évacuations."

† GURLT (E.) *Ueber den Transport Schwerverwundeter und Kranker im Kriege, nebst Vorschlägen ueber die Benuetzung der Eisenbahnen dabei*; in *Medicinische Zeitung des Vereins für Heilkunde in Preussen*, Berlin, 1858, S. 232.

‡ This plan, largely employed in the Army of the Potomac in 1863-64, was approved by the Prussian Government. An order, issued by the Prussian Minister of War, July 1, 1861, of which an abbreviated translation may be found in Professor LONGMORE's *Treatise on the Transport of Sick and Wounded Troops*, 1868, p. 501, directs that in transporting sick and wounded soldiers by railways, the first, second and third class passenger carriages will be appropriated to the less severely wounded, first and second class carriages to be used by officers and men requiring the most care, third class for slight cases. The severely wounded and those injured in the lower extremities will be moved in luggage vans or baggage cars. These are 20 feet long and 7¼ feet wide. The floors are to be strewn with loose straw, and then seven or eight severely wounded can be placed on straw mattresses, with pillows fastened to them, in each car. Great care must be taken to guard against fire, &c., &c.

Next, in chronological order, are the plans employed during the recent civil war in the United States for moving the sick and wounded by railway. After the action at Wilson's Creek,\* and minor engagements in central Missouri, in August, 1861, the severely wounded fell into the hands of the enemy. They were soon paroled, and concentrated at Rolla, the southwestern terminus of the St. Louis railroad, whither two hundred less grievously injured, and carried off by the retreating army, had previously been sent. Here, the freight cars available were fitted up for the transportation of this large body of wounded to the hospitals established at St. Louis. Various expedients were employed to adapt the cars to the requirements of the different classes of patients. In some cases



FIG. 1.—Interior of an improvised hospital car.

an arrangement not unlike that of Mr. Zavodovsky was essayed. Seasoned tent-poles were shaved down to give them as much elasticity as was compatible with requisite strength, and secured transversely near the roof, passing through holes in the side studs of the car. Ropes attached to these poles and also to the floor suspended two tiers of field stretchers, on which pallets were laid. With this plan, a feeling of insecurity was common to the patients

and attendants, and additional lashings, and constant inspections were necessary to prevent accidents. Another method consisted in placing a double row of upright stanchions which were erected on either side of the car (FIG. 1) connecting the floor and roof, at intervals of seven feet lengthwise. To these firm posts, tiers of two or three litters were securely lashed. In other cars rough wooden bunks were built along the sides of the vehicle, and filled with straw, and made more comfortable by being floored by narrow elastic slats. In all cases, large window-spaces were sawn out of the ends and sides of the car to afford ventilation. There was often cause to remark on the great ingenuity displayed, on this and other similar occasions, by the line officers, quartermaster's men, and the soldiers themselves, in improvising various contrivances for the comfort of the wounded subjected to these rough modes of transportation. With an intelligent adaptation of the means at hand, it was found practicable

\* Also known as the battle of Springfield, where the Union commander, the lamented General NATHANIEL LYON lost his life. Major General FREMONT's official report states the Union loss at 223 killed, 721 wounded, 291 missing. Assistant Surgeon H. M. SPRAGUE, U. S. A., who remained with the wounded on the field, records their number as 1175. See *Appendix to Part I, Medical and Surgical History of the Rebellion*, p. 17.

to make the condition of the wounded on freight cars very tolerable, with the aid of articles belonging to the field equipment alone. As the official who vouchsafed to assume charge of the models of hospital equipment and means of transport sent by this Office and by the Quartermaster's Department to the Paris Exposition, in 1867, and to exhibit them, with other contributions, as material supplied by the United States Sanitary Commission, has represented that the system of supporting litters on upright frames was introduced by a member of that Commission,\* it is as well to expose here the fact that this plan was in use before the Commission was organized.

After the Army of the Potomac left the vicinity of Washington, the sick and wounded were removed mainly by the hospital transport steamers on the Potomac, Rappahannock, York and James rivers. The short lines from Savage's Station to White House, on the York, and from Aquia Creek to Fredericksburg were largely utilized, however, for the same purpose; and when the theatre of hostilities was transferred to Maryland and Pennsylvania, numerous railway lines became available. Medical Director J. Letterman recorded the transfer† of no less than nine thousand sick and wounded over the Aquia Creek road, on June 12th, 13th, and 14th, 1863, when the Army moved northward after the disasters of Chancellorsville. All patients that would be injured by sitting up, were carried by hand to the railway, on the beds they occupied in hospital, the beds being placed on hay-covered floors in freight cars.

The following year, when this Army was massed before the entrenched line at Petersburg, a large dépôt hospital was erected at City Point, the base of supplies, at the junction of the James and Appomattox rivers. This dépôt was connected with the positions of the several army corps by a railroad with branches, and the sick and wounded from the division hospitals were brought to the dépôt, chiefly in the box-cars which had carried forward supplies for the troops, and were transferred to hospital steamers, or retained at City Point for treatment, at the discretion of the medical director for transportation, Surgeon E. B. Dalton, U. S. V. There were, at first, two, and, subsequently, a larger number of passenger cars converted into hospital cars by the erection of rows of stanchions, to which litters were suspended by elastic rubber rings, each car having accommodation for thirty recumbent patients. The box-cars, with doorways at the sides, five feet in width, and an interior height in the centre of 6 feet 9 inches, had a floor space of 25 feet 2 inches in length by 7 feet 8 inches in breadth, or about 192 square feet. They afforded comfortable accommodation for nine recumbent patients; but were sometimes packed with as many as twenty. When the floors were covered with a thick bed of fresh straw or hay, on which well-filled bed-sacks or mattresses could be laid, the concussions from

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\* Dr. T. W. EVANS, in his book entitled: *La Commission Sanitaire des États-Unis*, Paris, 1865, p. 133.

† LETTERMAN (J.) *Medical Recollections of the Army of the Potomac*, New York, 1866, p. 150.

the motion of these rough cars were so much deadened as not to be intolerable even to severely wounded men. There was a great advantage in carrying the wounded on the beds or litters on which they lay, through the wide door-ways of the box-cars, and unloading them, in like manner, at the depôt hospital or the wharves of the transport steamers at City Point. It was, however, very difficult to obtain an adequate supply of straw or hay, when, after a general engagement, train after train was sent in rapid succession, and recourse was sometimes had to bedding of dry leaves or evergreen boughs. In one of the reports to Medical Director T. A. McParlin\* it is stated that it was necessary to empty the bed-sacks of the field hospitals of a corps in order to obtain sufficient bedding for the box-cars of a train of wounded.

In the summer and autumn of 1862, and during the two succeeding seasons, four large brigades stationed at New Berne suffered from malarial fever to that extent that general hospitals, or rather sanatoria, of great capacity, were established on the sea-coast at Carolina City, near Fort Macon, the former connected with New Berne by a railway forty miles long. The patients were conveyed in freight cars, for there were no others available. The floors of the cars were covered with dry "pine tags" supplemented by a layer of loose hay or straw when it could be procured. The patients were laid upon bed-sacks on this substratum, and even those most gravely ill, were transported with comparative comfort. Medical Inspector E. P. Volland, U. S. A., has recorded † that after the battle of Gettysburg, July 1-3, 1863, over fifteen thousand wounded were sent from the field hospitals prior to July 22d, nearly all by railway to Baltimore, York, Harrisburg and Philadelphia. They were transported, in large proportion, in the box-cars of the returning supply trains. "Each car was supplied with a sufficient quantity of hay, and, on the longer routes, water-coolers, tin cups, bed-pans and urinals were placed on them." After the battle of Olustee, February 20, 1864, where the wounded of the Union side numbered over eleven hundred, Assistant Surgeon John H. Janeway, U. S. A., states that the grave cases of compound fracture and of penetrating wounds of cavities, and, indeed, all the more seriously wounded, were transported on the Mobile Railway on freight cars, bedded with pine boughs, palmetto leaves, and a small allowance of straw, covered with blankets. The trains moved slowly from Sanderson to Jacksonville, on the coast, a distance of nearly fifty miles, and patients who had undergone amputation, and others severely wounded, complained but little of the rough method of transit. In the campaigns about Chattanooga, also, Medical Director G. E. Cooper, U. S. A., reported that in emergencies, when the regular hospital trains were overcrowded, recourse was often had to transport by freight cars bedded with dry leaves.

\* A Report from the Fifth Corps headquarters by Assistant Surgeon C. K. WINNE, U. S. A.

† VOLLUM (E. P.), *Report on the Transportation of the Wounded after the Battle of Gettysburg*; in *Appendix to Part I Med. and Surg. Hist. of the War of the Rebellion*. Washington, 1870, p. 143.

In a letter to the Surgeon General, dated Philadelphia, January 7, 1863, Surgeon A. K. Smith, U. S. A., describes "a car recently fitted up by the Philadelphia Railroad Company for the better conveyance of the worse class of sick and wounded. \* \* \* The internal arrangements are similar to those of sleeping cars, with the exception that the berths slide in and out, and two men can carry each, with its patient, to the ambulance wagon or the nearest hospital, the berths being, in fact, comfortable stretchers. The car has fifty-one of these berths, and a seat at each end for an attendant. It is provided with a stove, on which soups can be cooked, a water tank and locker, and a convenient water-closet. It is proposed to use the car with the regular passenger trains, and to bring to Philadelphia cases of a more serious nature than can be selected for transfer by the ordinary mode of travel. This arrangement is entered into with great zeal by Mr. Felton, President of the road, the plan being in a great measure due to the efforts of Mr. William Welsh. If proved to work well, I am satisfied in saying that more cars will be similarly constructed for the purpose of bringing the seriously sick and badly wounded from

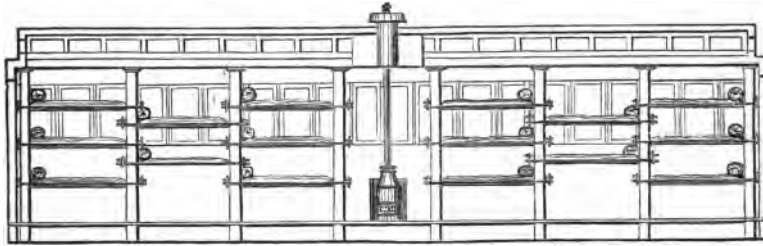


FIG. 2.—Longitudinal section of a passenger car fitted up as an hospital car. [After EVANS.]

Frederick and Harper's Ferry." This proposition was warmly seconded at Washington, and a number of passenger cars, converted to hospital requirements, and hospital cars also of special construction, were soon in operation on the railway lines connecting the theatre of hostilities with Baltimore, Harrisburg, Philadelphia and New York. They were not fitted up on a uniform plan, but under the auspices of different benevolent associations; but all secured a comparatively comfortable mode of transport for recumbent patients, and rendered almost inestimable service in relieving the crowded hospitals near the scene of hostilities. The hospital cars fitted out by the United States Sanitary Commission are understood to have been arranged in accordance with plans furnished by Dr. Elisha Harris.\* A model of one of these cars was exhibited at the Paris Exposition of 1867 (see FIG. 2). These cars were

\* STILLÉ (C. J.) *History of the United States Sanitary Commission*, Philadelphia, 1866, p. 161, HAMILTON (F. H.), *A Treatise on Military Surgery and Hygiene*, New York, 1865, p. 168, and EVANS (T. W.), *La Commission Sanitaire des États-Unis*, Paris, 1865, p. 133, et *Planche IV*. A letter on file in the Office of the Quartermaster General, indicates that Dr. HARRIS invited General MEIGS to inspect one of these hospital cars as early as March 20, 1863.

about fifty feet in length. A passage way extended through the middle to the doors at either end. On either side of the passage-way were eight upright wooden posts, three inches square, connecting the floor and ceiling, and so placed that the distances apart should correspond with the length of a field stretcher. At a distance somewhat less than the width of a field stretcher, opposite each pillar, another post of like dimensions was placed next the side of the car; thus one side-pole of a stretcher was attached inside the wall-pillar and outside the pillar next the passage-way, and its suspension was rendered easier than if it was confined between the rigid pillars. Wooden pegs inserted in the posts served for the attachment of large rubber rings (FIG. 3), which received and sustained the ends of the stretcher poles. Thirty-two litters could be suspended, leaving a space in the middle for a stove, and seats for attendants or wounded who could travel in a sitting posture. It is stated,\* that some of the india-rubber rings that had been in use in these cars were exhibited in Paris, in 1867, and were still in perfect order. I have been informed that these cars

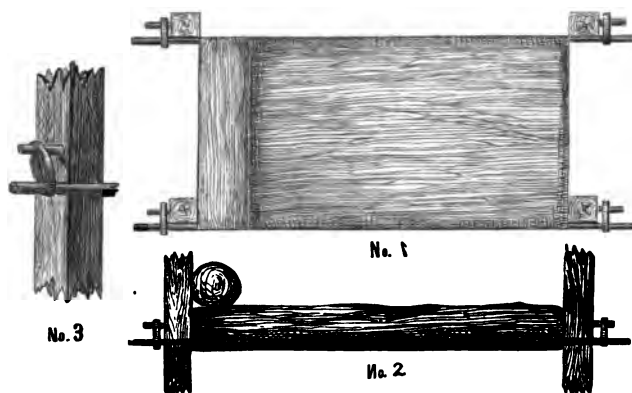


FIG. 3.—Mode of suspension of litters by rubber rings in the "Harris car," 1. Vertical view; 2. Lateral view; 3. Enlarged view of one of the rings. [After EVANS.]

inches wide, and it was this form of stretcher that was generally employed upon the hospital trains. Although the advantage of caoutchouc rings for the suspension of litters was generally conceded, and the inventor and exhibitor were rewarded with medals, many objections were raised to the arrangements of the car exhibited in Paris. Dr. Loeffler† declared that the inconveniences attending the transport of wounded in tiers of three superimposed berths were so considerable that the project must be abandoned. Professor Gurlt‡ referred

\* LONGMORE (T.) *A Treatise on the Transport of Sick and Wounded Troops*, London, 1868, p. 476.

† LOEFFLER (F.) *Das Preussische Militär-Sanitätswesen, und seine Reform nach der Kriegserfahrung von 1866*, Berlin, 1869, B. II, s. 251.

‡ GURLT (E.) *Abbildungen zur Krankenpflege im Felde u. s. w.*, Berlin, 1868, s. 5, Taf. II.

had doors of three feet in width; but even this space would be insufficient, if the litters were as wide as represented by Dr. Evans (FIG. 1). The ordinary field stretchers used in the United States were uniformly 24



to the danger of "the frequent jolting of the car, striking the poles of the stretchers against the posts and communicating concussions to the litters and the patients, which may have the gravest consequences for the latter." Professor Billroth\* objects to these and all other arrangements for the railway transport of wounded that cannot be extemporized.

When the Army of the Potomac advanced to the line of the Rapidan, the Medical Director of the Department of Washington, Surgeon Robert O. Abbott, U. S. A., recommended that an hospital train of twelve cars, one fitted up as a dispensary and store-room for supplies, one for the surgeon in charge and attendants, and ten for the sick and wounded, should be constructed on plans and specifications prepared by the Assistant Superintendant of Military Railroads, J. McCrickett,† remarking that "during the past year two or three cars somewhat similarly fitted up, provided with medical officers, nurses and the proper medical appliances, have been running, under my direction, between this city, Philadelphia and New York, and I make this request upon my experience of their practical working, and the satisfaction they have given to patients, their friends, and this office.

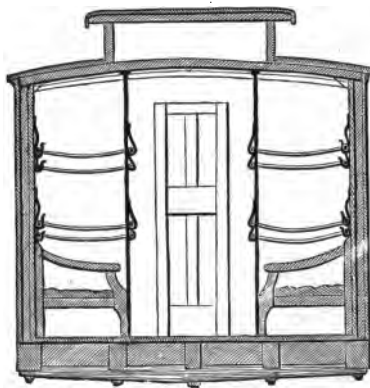


FIG. 4.—Transverse section of the hospital cars on the Orange and Alexandria railroad.

At present, the sick and wounded are transported in cars, illy adapted for the purpose, and with difficulty spared from the other pressing demands, and lives are lost on the route, not infrequently, which in all probability might be saved by a more comfortable and easy method

\*BILLROTH (Th.) *Chirurgische Briefe aus den Kriegs-Lazarethen*, Berlin u. s. w., 1872, s. 71.

†Mr. J. MCCRICKETT estimated that the twelve cars could be built in thirty days, at an expense not exceeding \$30,000, if the task of construction was divided among the factories at Wilmington, York, Harrisburg, Philadelphia, and Springfield, Massachusetts. He thought it "much better in many respects to have the cars made to order than to buy them at second-hand and have them altered," since railroad companies "can ill spare any of their rolling stock at this season, and would sell only worn out or condemned cars, the alteration and fitting up and repairs of which, added to the prime cost, would demand a greater sum than would be required for new hospital cars." It is impracticable to ascertain from the records of the Bureau of Construction of Military Railways, whether a full train was built in accordance with the plans and specifications of Mr. MCCRICKETT, prepared in consultation with Surgeon E. BENTLEY, U. S. V. It is known that the construction of a number of hospital cars was authorized about this time, at different car-shops, and that several hospital trains were soon in operation on the Orange and Alexandria line; but they were not of uniform patterns. In many of them, the litters were suspended by india-rubber rings. It is probable that the cars constructed under the direction of the Sanitary Commission and those built by Government order would often be connected or separated on the different lines as the exigencies of the service required.

of transportation. These considerations and the extended facilities such cars will give for the transportation of the wounded particularly, will, in my opinion, justify the expense of construction." It was designed that this hospital train should ply between the advance of the army, near Culpeper, and the base hospitals at Alexandria and Washington, and should supplement or supersede the freight-cars bedded with straw or hay that had been hitherto in use. The Surgeon General and Quartermaster General cordially endorsed this project, and several complete hospital trains were soon in operation on this line.

FIGURE 4 is a reduction from Mr. McCrickett's "end elevation of the hos-

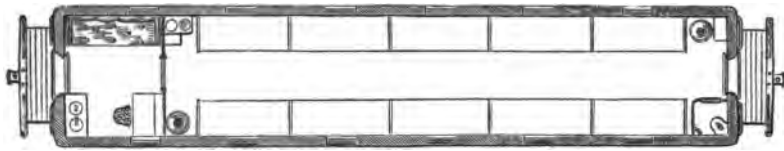


FIG. 5.—Horizontal section of the hospital cars on the Alexandria railway.

pital car, showing the litters in place, and the mode of hanging them. The bottoms of the permanent couches, two and a half feet wide, are made either of wooden slats or of canvas, with mattresses laid upon them. For the second and third tiers, ordinary field stretchers are used. The inside poles of the litters are suspended by a leathern strap or by strong webbing, the strap secured

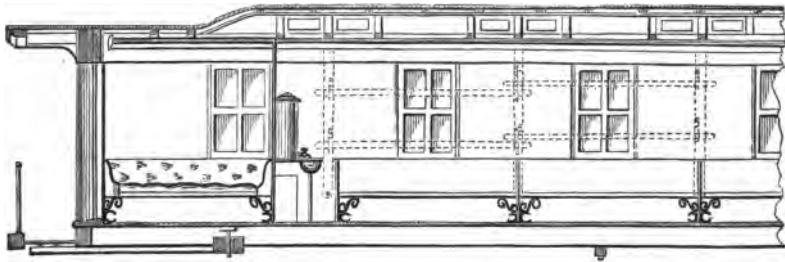


FIG. 6.—Lateral elevation of a part of one of the cars on the Alexandria line.

to a carling of extra strength; the outside handles of the litters are supported by hooks of spring steel. There should be some space between the inside litter handles and the side of the car to prevent concussions; the hooks so constructed as to act as springs. The litters of the second and third tiers, when not in use, can be taken down, and folded under the permanent couches. The straps also can be taken down or rolled up; there will then be no obstacles in the way when loading the cars with patients. A door three feet and a half wide, *at one end*,\* gives ample room for ingress and egress of loaded stretchers. The aisle is three feet and a half wide and can be occupied by folding chairs for

\* At the other end, represented in the elevation (Fig. 4), the door opening into the attendant's room is only two feet wide.

those who can travel in a sitting posture, the chairs being stored under the permanent couches. The capacity of the car, which measures inside eight and a half feet in width, forty-five and a half feet in length, and six feet eight inches in height, permits the transportation of fifty or sixty patients; thirty in couches and the others in chairs." FIGURES 5 and 6 explain themselves.

Descriptions of the cars specially fitted up with rooms for kitchens, dispensaries, store-closets, quarters for the employés of the train, offices for the executive officer, etc., must be deferred until the more detailed report is made, which it is proposed to include in the last part of the Surgical History of the late war. With the addition of such special cars a well organized railway ambulance train became a nearly complete movable hospital establishment, with every reasonable appliance for the sustenance, dressing, nursing, and medication of the patients. The hospital trains of the armies in the East traversed railways within the Union lines, and were seldom molested. They were moved generally at a low rate of speed. They were distinguished by displaying the yellow hospital flag near the engine, and by the inscription "U. S. Hospital Train" printed in large letters on the panels of the cars.

The hospital cars prepared under the supervision of the Government officials, and those arranged under the direction of the agents of the Sanitary Commission, were usually passenger cars converted to hospital use, although the kitchen and executive cars, and a few of those for the conveyance of the sick and wounded were built specially for the purposes they were designed to subserve. There was great variety in the details of the internal arrangements; but nearly all conformed to the general plan of securing berths in tiers to rows of uprights. The cars constructed by different builders varied in dimensions. The longest were 58 feet in length including the platforms. The usual interior length was 45 to 50 feet, which afforded space for five or six sections of stretchers on each side, and space for stoves, lavatories, water-closets, and seats for attendants. The height at the sides was  $6\frac{1}{2}$  feet, the roof sloping upwards to  $7\frac{1}{2}$  feet, and being surmounted by a clear story of 2 feet provided with windows and ventilators.

It was in General George H. Thomas's Army of the Cumberland, of which Surgeon George E. Cooper, U. S. A., was Medical Director, its long line of communication extending hundreds of miles away to its base of supplies, that the utility of railway transport, in relieving the army of its disabled men, was most conspicuous. Although freight cars were used for very severe cases, several trains of hospital cars of special construction were prepared at the government work shops, for the conveyance of patients in the recumbent posture. In 1864, there were three hospital railway trains, each consisting of ten or twelve cars, with several freight or baggage cars attached sometimes, connecting the advance of the army with Nashville and Louisville; one train, at least, daily leaving the vicinity of the field hospitals. In each train, one car was fitted up exclusively as a kitchen and store-room, and another as a dispensary,

with accommodation for the medical officer in charge, and an ample supply of medicines, stores, instruments, and appliances. Surgeon Cooper reported that upon his arrival in the Department, a train of passenger cars fitted up for the transport of sick and wounded by Acting Assistant Surgeon J. P. Barnum, was already in operation on the line, a hundred and eighty-five miles in length, between Louisville and Nashville. This train had been prepared at Nashville under the direction of the Western Sanitary Commission. Each of the cars accommodated thirty-three recumbent patients. The pallets were placed in tiers of three, supported by iron brackets attached to the sides of the car, and swung on india-rubber springs (FIG. 7). "The bed frames," Surgeon Cooper remarks, "resemble stretchers with a portion of the handles sawn off. This style of car

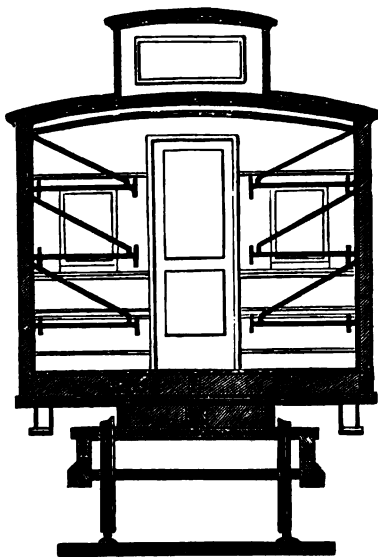


FIG. 7.—Transverse section of a passenger car fitted out by Acting Assistant Surgeon J. P. Barnum, and known as the "Harris Car."

is objectionable on account of the surgeon being unable to manipulate the wounds when they require dressing, without great inconvenience to himself. The space between the beds is too contracted, and causes much complaint from the wounded. There is too much motion in the beds, and altogether the car is not a good one." Dr. Barnum states that during his connection with the railway hospital service, he "supervised the transportation of 20,472 patients, and lost but one; who, despite the advice of his surgeons, implored that he might be taken to die in the bosom of his family."\*

The cars thus arranged, and others in which litters were suspended by india-rubber rings, from pegs inserted in upright posts, as in the Eastern hospital trains, were alike known at the West, under the designation of the "Harris car." Dr. F. L. Town, U. S. A., in a report to Assistant Surgeon General Wood, refers to them as follows: "Other ways of securing the beds have been tried. The 'Harris car' is in use, with beds arranged in three tiers,

\* EVANS (T. W.) *Loc. cit.* p. 135. Medical Director COOPER doubts this remarkable immunity from deaths in transit on the hospital trains directed by Dr. BARNUM; while testifying to the indefatigable zeal and efficiency of the latter during his protracted service. "Acting Assistant Surgeon J. P. BARNUM," remarks Dr. TOWN, "had charge of the first hospital train built at Nashville. He studiously labored to improve and systematize its working, and devised many expedients looking to the comfort of the patients, in days when the theory of hospital trains was not so well understood as now."

each bed resting on stretchers, suspended by four rubber rings, between uprights. Each rubber ring encircles a pin in the upright, and holds up one end of the lateral bar of the stretcher. This arrangement has one advantage; the stretcher can be unshipped, and, if necessary, the occupant can be borne away without disturbing him. A ward in the 'Harris car' contains thirty-three or thirty-six beds. The removal of one section of the tiers, that is three litters,

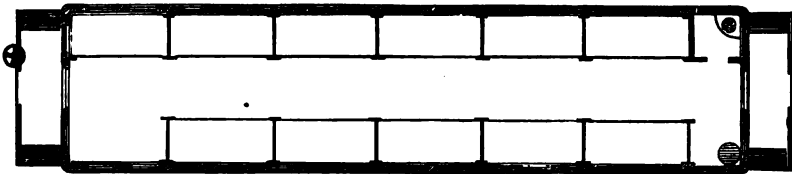


FIG. 8.—Reduced plan of a horizontal section of one of the cars of Dr. Barnum's train, showing the positions of thirty-three litters, the wash-room and water-closet. [From a drawing furnished by Medical Director COOPER.]

affords room for a stove in cold weather. The 'Harris car' has not worked well in practice. The elasticity of the rubber bands keep the bed in constant

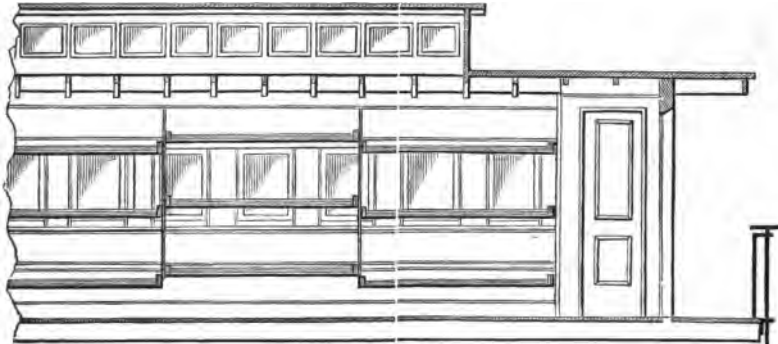


FIG. 9.—Lateral view of half of an hospital car of Dr. Barnum's train, showing the arrangement of the litters, and the wide side door. [From a drawing from Dr. COOPER.]

vibration while the car is in motion, to the great annoyance of the patients, who complain of reclining on what they term 'a capering bed.' Severe cases are now conveyed in the cars to be hereafter described."

FIGURES 8 and 9 further illustrate, by horizontal and lateral views, the arrangement of one of the hospital cars of Dr. Barnum's train. They are reductions from drawings prepared for Dr. Cooper by a draughtsman of the Nashville Car Manufactory. Some further particulars respecting the method of suspending litters by rubber tugs or rings, and the means of obviating the excessive oscillation often complained of as a grave objection to this system, will be noticed further on.

Medical Director George E. Cooper preferred the arrangement of the ordinary first class passenger cars on the plan indicated in FIG. 10. The cars of this class were usually fifty-five feet long, and nine feet four inches wide, with a doorway twenty-two inches wide at either end, a passage way of equal width through the middle, and, on either side, a row of fourteen double seats. Dr. Cooper

describes the arrangement (Figs. 5, 6) he commends as follows: "The cars thus prepared have a capacity for thirty-three patients. The beds are made by removing the alternate seats, and connecting the remaining seats with slats of ash, or some other springy wood. Two bed-sacks are laid on the slats. The wounded are carried on the slats covered with bed-sacks, and are placed two on each bed. The upper beds are framed as stretchers, and are hooked to the side and ceiling of the car, and covered with a mattress. On this upper tier the less gravely wounded are carried. This plan was found to be the best, the least expensive, and the most comfortable to the patients of all the hospital cars in use. The medical attendants could dress wounds in these cars without much inconvenience." On

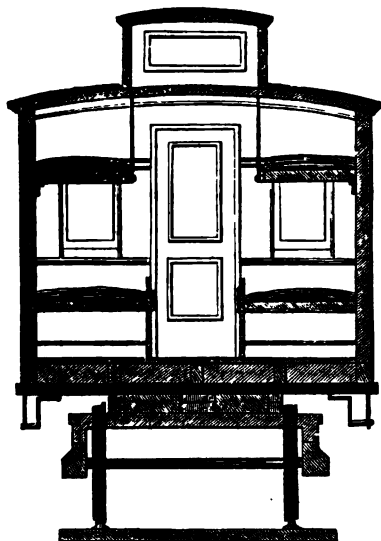


FIG. 10.—Transverse Section of hospital car of the Army of the Cumberland. Pattern of Drs. Cooper and Herrick.

the drawings sent with this description, Surgeon Cooper annotates: "This is the simplest and best form."

Dr. F. L. Town, U. S. A., gives the following description of five of these cars which he inspected: "Each ward contains about twenty-four beds, arranged lengthwise along either side of the car, in two tiers; the upper bed exactly above the lower. In the lower tiers, the bed is fixed firmly upon the car seats; the backs of these [and an intervening seat] are removed. Its width is that of the car seat, [about forty-four inches] and its distance from other beds is the space between adjacent seats. In the upper tier the beds are about two-thirds as wide, and are on stretcher-frames, attached firmly on the outer side to the wall of the car, and suspended on the inside by two iron bars from the roof. Each upper bed thus stands or hangs immovably in its place. The wide beds in the lower tier are considered double, and, on short routes, are often occupied by two patients, regarded as mild cases. The American railway companies appreciate economy of space in their sleeping cars, and the plan of transporting two persons in one bed is not claimed as original in hospital trains. The hospital

car is supported on trucks, with elliptical steel springs, as is usual in passenger cars, and, in addition, india-rubber springs are so arranged as to equalize the motion and deaden the jarring of the car. This is a very valuable improvement, and adds much to the comfort of the patients. In the wards above described, the patients ride with much ease and every possible provision for their comfort." FIGURE 11 presents a reduced plan of one of these cars.

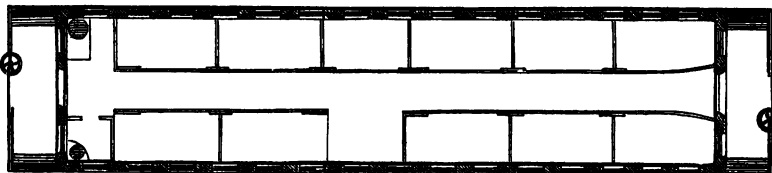


FIG. 11.—Horizontal plan of one of the hospital cars of the Army of the Cumberland.

These cars were fitted up under the immediate supervision of Medical Director Cooper and of Surgeon O. O. Herrick, 34th Illinois Volunteers. The latter was, at one time, in charge of one of the trains, and is officially reported as having rendered signal service in devising expedients for facilitating the safe transport of wounded, and in promoting the organization and administration of the system. General Thomas accorded the fullest authority to Medical Director Cooper to select for the hospital trains the best locomotives and cars to be found among the rolling stock, and to have new cars fitted up whenever necessary, and caused to be detailed for the hospital service the most experienced conductors, engineers, and other employes of the several railway lines. Medical Director Cooper informs the reporter that the smoke-pipes of the locomotives of the hospital trains were painted of a brilliant scarlet; the exterior of the hood, and of the tender-car with water and fuel, were of the same conspicuous color, with gilt ornamentation. At night, beneath the head-light of the engine, three red lanterns were suspended in a row. These distinguishing signals were recognized by the Confederates, and the trains were never fired upon, or molested in any way. Dr. Cooper "was informed by wounded Confederate officers in Nashville, who were captured at the battle near that place, of the stringent orders given his troopers by General N. B. Forrest for the non-interference with and protection of the U. S. A. Hospital trains," by giving them timely warning in the event of the railway being obstructed or torn up. The partizan troops of Colonel John Morgan's command had similar instructions. It is related that on one occasion Colonel Morgan's scouts stopped the train directed by Dr. Barnum, and having switched it off upon a siding, after enquiring if there were sufficient stores on the train for the sick and wounded, they tore up the main track, and then rifled and destroyed five supply trains that successively arrived at the point where the line was interrupted.

Ventilation, without exposure to drafts, was well provided for in these cars by

windows in the elevated part of the ceiling, and by valvular openings near the roof (FIG. 12). Dr. Town comments on the admirable manner in which the apparatus for lighting and heating were made also to promote ventilation. He refers

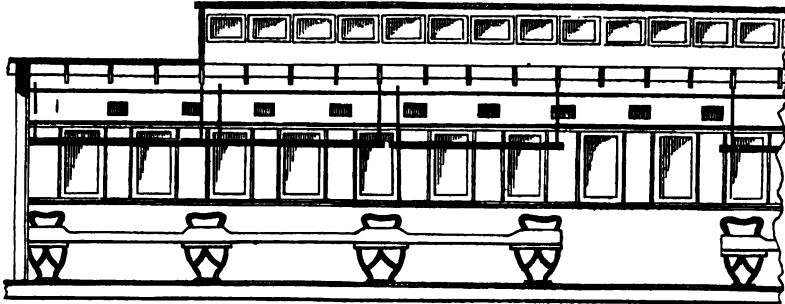


FIG. 12.—Side elevation of one of the hospital cars constructed under Dr. Cooper's supervision.

to many other details, which there is not space to notice here, and concludes that "the conception of a complete hospital, with all its appliances and means of comfort, propelled by steam, was first carried into practical operation in the medical department of the West, and its perfect success was most gratifying to all. In visiting these hospital trains, the air is found sweet and pure, the wards neat and inviting, and it may unhesitatingly be said that men on hospital trains are often as comfortable, and better fed and attended than in many permanent hospitals." Besides Drs. Barnum and Herrick, Medical Director Cooper mentions Surgeon L. J. Dixon, 1st Wisconsin Volunteers, and Assistant Surgeon E. J. Darken, U. S. A., as having supervised hospital trains with great skill and devotedness. Of the Medical Director himself, Dr. Town observes: "Colonel George E. Cooper has made the study of hospital railway trains his pride. All of the western trains have been in the Department in which he directs the medical service, and many of the cars have been fitted up under his supervision. \* \* \* He has just cause to be proud of his hospital trains. As far as the records of the Assistant Surgeon General's Office show, the first official step towards organizing hospital cars was a letter written August 11, 1863, from that Office by Surgeon Joseph P. Brown, U. S. A., (during the temporary absence of the Assistant Surgeon General on other duty) directing the Medical Director of the Army of the Cumberland 'to take immediate measures to fit up a special train for hospital purposes, with every possible comfort,' to run between Nashville and Louisville."

When General Sherman's army was before Atlanta, until the lines of communication were destroyed preparatory to the march to the sea, hospital cars ran regularly from the front to base hospitals, some of which were four hundred and seventy-two miles distant.\*

\* Surgeon F. L. Town's report.



The difficulty of introducing loaded stretchers or litters through the narrow end doors of the converted passenger cars was obviated, in the train prepared under the supervision of Drs. Cooper and Herrick, by leaving the middle section on one side free from beds, removing two windows and the panelling beneath, and introducing a sliding door, six feet in width, affording an ample space for the ingress and egress of litters with the most severely wounded patients. Descriptions of the kitchen, office, and dispensary cars, which added greatly to the efficiency of these trains, are omitted here. A further description of the hospital trains of the Army of the Cumberland has been given by Dr. Dallas Bache, U. S. A.\* In addition to the illustrations that were published with his paper, it may be useful to add diagrams explaining the details of the arrangements for suspending litters from upright posts in adapting cars for hospital purposes (FIGS. 13, 14, 15) that were planned by Dr. Harris, in December 1862, and successfully put in practical operation in the Spring of 1863.† It has been shown ‡ that the adaptation of cars to hospital purposes by securing field stretchers to rows of stanchions was practised from a very early period of the late war; but the merit of devising a simple and effective method of suspending the stretchers by rubber rings was exclusively due to Dr. Elisha Harris, who, moreover, promoted with great

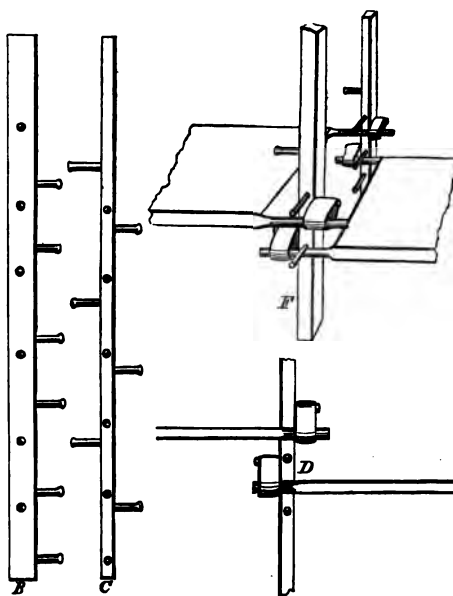


FIG. 13.—Uprights and elastic ring couplings for suspending litters in hospital cars. B. The upright post next the passage-way; C. The fellow-post next the side of the car; F. Oblique view of the coupling by rubber bands; D. Lateral view of the coupling by rubber bands. [After HARRIS.]

\*See Report of Assistant Surgeon D. BACHE, U. S. A., in *Appendix to Part I, Medical and Surgical History of the War of the Rebellion*, p. 289.

†Since the foregoing portion of this report was in print, Dr. HARRIS has very kindly placed at the disposition of the Surgeon General's Office, the original specifications and drawings of his plan for railway hospital carriages, together with many memoranda of the early trips of the cars first constructed, copies of much interesting correspondence on the subject, and samples of rubber bands in good condition, that had been for two years in daily use. I hope to avail more largely of these valuable sources of information in treating of this subject in the third surgical volume of the *Medical and Surgical History of the War*.

‡Pages 6 and 7 ante.

earnestness, during the war, the establishment and organization of railway transport for the sick and wounded. A brief and somewhat inaccurate account of this system was published in 1865 by Professor F. H. Hamilton.\* The plan was cursorily alluded to the same year, in a surgical report from this Office,† and more fully described in a work by Dr. T. W. Evans, of Paris.‡

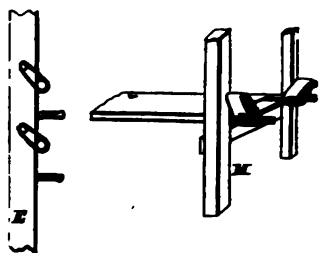


FIG. 14.—The "free" or inside method of suspending litters by rubber rings. [After HARRIS.]

Dr. Harris proposed to suspend three tiers of litters from upright oaken stanchions 4 inches wide by 2 inches thick, extending from the floor to the roof of the car, which gave a length of about 6 or 6½ feet (FIG. 13, B and C). The stanchions were placed in pairs, the fellow posts 22 inches apart, and 6½ feet distant from the next couple (FIG. 19). The stanchions at the end of each row of uprights were perforated to receive on the broad face

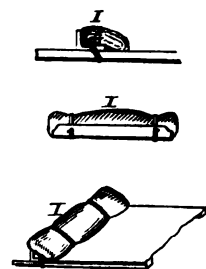


FIG. 15.—Pillows for stretchers. [After HARRIS.]

three hickory pins an inch in diameter, and three on the narrow face; the other stanchions, each pair contributing to the support of two tiers of litters, were provided with twelve pins (FIG. 13, B, C), six termed holder or loop pins, and six arresting pins or stops (FIG. 13, F, D), designed to prevent the undue descent of the litter. Around the pins on the broad face of the pillars were placed loops or tugs of vulcanized india-rubber, 3 inches broad, ½ inch thick, with 4 inches aperture, and weighing 9½ ounces Troy. The handles of the stretchers, sawn off at 7½ inches from the margins of the canvas, were inserted in the rings, which were put upon the stretch by the weight of the patient. Too great oscillation was prevented by the stopping pins, or by substituting more massive rubber rings. The holder-pin for the lower stretcher was 9½ inches from the floor, the stop-pin, 3 inches. The space between the upper and middle, and the middle and lower stretchers was about 19 inches. The inside length of the cars fitted up varied from 41 to 47 feet, and would accommodate four or five tiers of litters on either side, with space reserved for seats, closets, and offices at the ends. The inside width of the cars

\* HAMILTON (F. H.) *A Treatise on Military Surgery and Hygiene*, New York, 1865, p. 168. The remarkable statement is made that: "The stretchers are suspended on loops made of gutta-percha," a singularly unsuitable material.

† Circular No. 6, S. G. O., Washington, 1865. *Reports on the Extent and Nature of the Materials available for the Preparation of a Medical and Surgical History of the Rebellion*,—*Surgical Report*, p. 84. Diagrams were given (FIGS. 88, 89, 90), from a photograph by Gardner, of the working drawings of the first hospital car exhibited by Dr. HARRIS in Washington, in March, 1863. I found the photograph on file, but, at that time, could obtain no precise information of its origin.

‡ EVANS (T. W.) *La Commission Sanitaire des États-Unis, etc.*, Paris, 1865.

was 8 or 8½ feet, and as the two series of berths occupied but 2 feet 4 inches on either side, a passage-way of 3 feet 4 or 10 inches was left in the middle. The end doors, usually opening 2 feet, were widened to 2½, or, in the best models, to three feet. Hair pillows (FIG. 15) were attached to head-boards of



FIG. 16.—End elevation of one of the hospital cars used in the West. (Circ. 6.)

½-inch light wood, and secured by straps to the litter poles. Dr. Harris proposed a modification of this plan designed to afford greater elasticity to the litters for the transport of severe cases. The inner edges of the upright stanchions were placed 26 inches apart, and the handles of the litter were hung

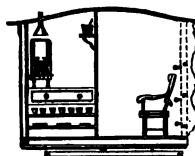


FIG. 17.—Section showing dispensary and culinary closet. (After HARRIS.)

between the posts (FIG. 14, M); a wooden or iron traverse was substituted for the stop-pins, and the mode of insertion of the pins in the uprights was altered (FIG. 14, E); larger rubber rings, weighing 12 ounces, were used. On experiment, this plan was found inferior to the first. Most of the cars were provided at one end with a wash-room and water-closet (FIG. 19), and at the other end with a couch and seats for attendants, a stove, and a small closet (FIG. 17) for a few essential medicines and dressings, and a copper boiler with

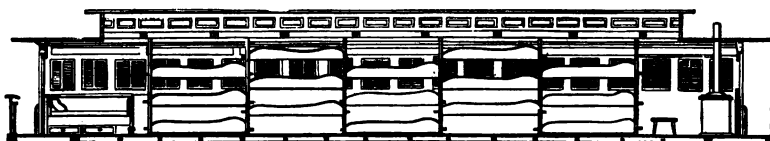


FIG. 18.—Lateral View of one of the cars used on hospital trains at the East. (Circ. 6.)

an alcohol lamp. This brief statement of details applies to many of the long passenger cars fitted up for hospital purposes upon specifications supplied by Dr. Harris. This original design of Dr. Harris was not, however, limited to transforming passenger cars to hospital use;\* and the adaptation of elastic rubber rings to the suspension of litters, though valuable, was not the most important and enduring part of his system. There will probably be many changes and improvements in the methods of moving wounded men by railway; but the idea of utilizing the ordinary field stretchers for railway transport, keeping the patients upon them until they reach a fixed hospital, will not soon be abandoned.

\*Dr. HARRIS wrote me, August 17, 1875; "The original sketch, made in June, 1862, is now before me, with the simple proposition: *To readily and securely suspend in any railway car, as large a number as possible of the field litters, as portable hammocks, to be passed onwards, as beds for patients, without delaying or encumbering transportation.* The method of swinging in position, and securely fastening the litters was settled in the first pencil-sketch; the details of a complete ambulance car were arranged the last week in December, 1862, and the first car fitted up, the pioneer, was the favorite old 51-foot car, that was mutilated, when occupied by the 6th Massachusetts Volunteers, in the Baltimore riot, of April, 1861."

This expedient had been already resorted to in isolated instances; but Dr. Harris proposed its systematic adoption, and devised a feasible method for its accomplishment. The system was much commended in Europe.\*

At the close of the war there were in use thirty-nine cars that had been fitted out under the supervision of the Sanitary Commission. Except in a few

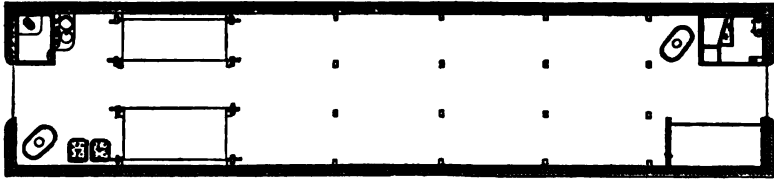


FIG. 19.—Longitudinal plan of one of the hospital cars used at the East. (Circ. 6.)

instances, however, the Government had reimbursed the Commission for the original cost and the expenses of the outfit.†

Few published statements have appeared respecting the transportation of sick and wounded in the Confederate armies. There is a chapter on the subject in Dr. Chisolm's manual,‡ but no allusion to transport by railway. Apart from some sensational newspaper stories, Assistant Surgeon C. C. Gray's concise description§ of the removal of wounded Union prisoners in freight cars from Manassas to Richmond, is the only account of the transportation of wounded on railroads by the Confederates that has been printed. I have been favored, however, by Dr. Howell L. Thomas, of Richmond, with brief memoranda on the subject from several medical gentlemen who had the best opportunities of obtaining accurate information relating to it. Dr. Samuel

\* HAUROWITZ (H. v.) (*Das Militär-sanitätswesen*, 1866, S. 87) observes: "Every military man, who has served in the field, will understand the difficulties of all kinds that obstruct the transportation of large numbers of sick, and must thank the United States Government for the introduction of a system of transportation that leaves nothing to be desired, and may serve as an example for all similar occasions. It is true the necessary expenses were enormous; but the people readily and cheerfully offered what was requisite when once aware of the necessity, and the benefit of the system to the suffering soldiers." \* \* "The manner of transportation forms a systematically arranged whole, and as a part of the sanitary system is exclusively under the direction of the Surgeon General. Forty complete specially arranged railway cars constantly stood at designated stations in readiness to go whenever required. Every such car might properly be considered a movable hospital, furnished with beds, utensils, cooking apparatus, provisions, a miniature dispensary, in short with every thing necessary."

† I make this statement subject to correction. Dr. HARRIS has informed me of numerous instances in which the purchase money and cost of furnishing was refunded by the Government, and I know of several occasions on which the Quartermaster General's Department assumed the bills as soon as the hospital cars were placed under the control of Government officials. A few cars, thoroughly furnished for hospital transport, were presented to the Government by railroad corporations, one by the Camden and Amboy Co., one by the Philadelphia, Wilmington and Baltimore Co., and, possibly, by some others. A model memorial car, built after the war, and exhibited in Paris and at Gettysburg, was unfortunately burned at Camden.

‡ CHISOLM (J. J.) *A Manual of Military Surgery, for the Use of Surgeons of the Confederate Army*, Columbia, 3rd ed., 1864, Chap. III, pp. 99-106.

§ GRAY (C. C.) *Report of Services at the first battle of Bull Run in Appendix to Med. and Surg. Hist. of the War of the Rebellion*, p. 7.

Preston Moore, Surgeon General of the Confederate Army, states, August, 1875: "Freight and open box cars were used to transport our wounded from the field to the hospitals. In the beginning of the war these cars were bedded with straw or leaves, whichever was most convenient. It was soon found that this bedding became so foul as to be very unpleasant. This plan was therefore discontinued, and the wounded were placed on blankets, when they could be had, spread on the floors of the cars. Stretchers were not used. \* \* Passenger cars were not used for severely wounded patients, the freight and open box cars being preferred. The Confederates had no regular system of hospital trains. As far as possible this idea was carried out, but oftentimes the exigencies of the service forbade its regular adoption."

Dr. Hunter McGuire, Medical Director of General T. J. Jackson's Corps, remarks, upon the same date: "We used freight cars in transporting wounded men, and sometimes sick men, using straw or dry leaves for bedding. Stretchers were very scarce, and occasionally an officer or very badly wounded man was permitted to take one away. Sometimes we suspended one of them by ropes fastened to posts on the side of the car. We had few ropes, and no rubber rings. Passenger cars were also used. Planks were fastened on the tops of the backs of the seats; these slats were covered with beds, upon which the patients were laid. I remember only one regular hospital train, running from Guinea's Station [about twelve miles from Fredericksburg] to Richmond. It was made up partly of freight and passenger cars arranged as above represented."

Dr. Howell L. Thomas, who was stationed in or about Richmond during the war, relates the following facts on the subject: "Freight cars and flats were very generally used for the transportation of the wounded. The floors of these cars were usually covered with dry leaves or straw, as the locality best afforded; and in the absence of those, the best use was made of blankets, and other spreads, for relieving the hardness of the floors. Stretchers were not much in vogue, especially at the latter part of the war, when their scarcity prevented much resort to them. All sorts of intended comforts were improvised by attendants from the limited means at command. There were no ropes or rubber rings in stock. Passenger cars were converted to the use of recumbent passengers by laying temporary supports of boards upon the seats or the backs thereof, converting them into bunks, and making them hold two patients. Stretchers were used in such cases when they could be had. There were regular hospital trains once a day or oftener, from post hospitals to the field. They were in charge of regular medical officers with their aids, who were furnished with such supplies as would serve in emergencies. These trains were composed of freight and passenger cars, and the patients were quartered in one or the other according to their condition. Many of the passenger cars, if my recollection serves me, were bunked up (2 or 3 tiers) on the sides. But, except for emergencies, this close order was not resorted to."

We must now examine the different plans for railway transportation of the wounded that have been practised in European countries. Their number and variety attest the interest felt in the subject.

In the international conference of the societies for the relief of the wounded in war, held in Paris, in 1867, under the presidency of the Duc de Fezensac, a number of practical tests were instituted of contrivances for the transport of wounded by railway. First, experiments were made on the plan largely adopted by the Prussians in the Danish war of 1864 and in the Six Weeks War of 1866;—by the Austrians also, in the latter war, and by the armies in the United States. Two persons, one lying on a mattress, the other on a bed-sack filled with straw, were laid upon the floor of a freight car, and the train was set in motion. The vibrations of the car, transmitted to the pallets, soon caused an inconvenient amount of jarring to the persons lying on them, and it was adjudged that their elasticity was insufficient to protect patients from hurtful disturbance. Dr. Gurlt justly remarked that the experiment was incomplete, since the floor of the car was not covered with loose straw. It might have been added that the jarring is greater when cars are very lightly loaded. Baron Mundy stated that, in his experience as director of the trains of wounded of the Austrian army in 1866, loose straw was a very defective material for affording elasticity under such circumstances, rapidly becoming displaced from under the bodies of patients, accumulating in heaps, and then easily broken up and matted. Professor Longmore, who was present at these experiments, and described them in the treatise already cited, well observes that “the question of success or failure attending the employment of loose straw for breaking such concussions as are met with in the rougher kinds of railway conveyances when in motion, seems to resolve itself principally into one of the quantity of material employed.” With plenty of fresh straw, satisfactory results may be had; but it is often impossible to secure the requisite supply, train after train, for a large army in an active campaign. Hence the importance of some expedient that may be constantly available.

Among the contrivances for sick-transport of every description exposed in the Champ de Mars on the occasion referred to, were several specially designed to facilitate the transport of wounded on cars ordinarily in use on railways. One of these devices, presented by the Baden delegation, attracted especial notice, and was subjected to experiment on the branch of the Western railway that entered the Exposition grounds. This apparatus, manufactured by Messrs. Friedrich Fischer & Co., of Heidelberg, has been described by Professor Longmore, and in greater detail by Professor Gurlt, from whose magnificent iconographic work\* a condensed account is here compiled, with much-reduced copies of the

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\* GURLT (E.) *Abbildungen zur Krankpflege im Felde auf Grund der Internationalen Ausstellung der Hilfs-Vereine für Verwundete zu Paris, im Jahre 1867, und mit Benutzung der besten Vorhandenen Modelle*, Berlin, 1868.

accompanying drawings. The apparatus is intended for use in covered baggage cars, the litters being suspended upon swinging bars of tough wood. The bars or poles are provided at each end with iron caps or bands with projecting loops, connected by leathern straps and buckles with iron hooks. The bars are hung transversely about four feet apart (Fig. 20) to iron rings secured by eye-bolts in the side of the car. These rings are commonly found in cattle cars, in the proper places; but if not they must be inserted (FIG. 21). On each pair of the swinging bars, (and one pair is put in the fore-part and one in the rear-part of the car) two or three litters may be placed, which permits six recumbent patients to be carried on the swinging cross-bars. The litters

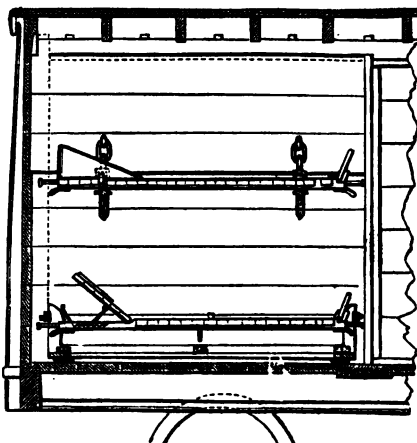


FIG. 20.—Longitudinal section of one-third of a baggage-car, with litters swung on the Baden plan. [After GURLT.]

consist of a wooden frame, on the upper surface of which are stretched, transversely and longitudinally, broad, closely-interlacing hempen bands of girth webbing. There are foot-boards perforated for the attachment of apparatus, and well upholstered pillows support the head. They are furnished with handles of three-fourths of an inch iron tubing, which, when not in use, slide into the side-poles of the stretchers, and thus diminish the space occupied by the latter in the cars. There are also supplementary leathern loop-handles (FIG. 20) and straps by which the litters may be buckled, to restrain their sliding on the transverse bars. A similar plan may be applied to third-class cars, (which in Germany are not subdivided into compartments). The cross bars used for this purpose are shorter, their extremities similarly provided, however, with hooks. The bars are hooked to the upright backs of the seats, and hang lengthwise in the car, and two or three litters may be laid upon them transversely. But the contrivance was best adapted to the covered freight cars and fourth-class passenger cars used on the German railroads.

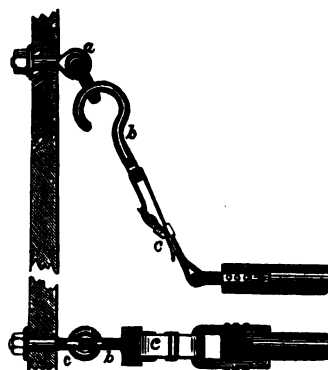


FIG. 21.—Enlarged view of the mode of suspending the swing bars. a, eye-bolt and ring; b, hook; c, strap and buckle. [After GURLT.]

On these cars, beneath the litters perched on poles, there is room for four swinging litters or camp bedsteads (FIGS. 22, 24), and space for a fifth in the middle of the car. A vacant space must be left alongside for the attendant and his utensils, and for ingress and egress. Thus eleven recumbent wounded may be

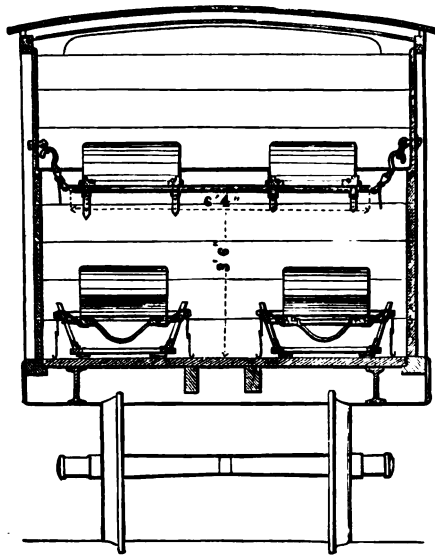


FIG. 22.—Transverse section of a baggage-car arranged on the Baden plan. [After GURLT.]

carried in one car. The swinging litter, laid on the floor of the car, is provided with a lower frame work consisting of three panels, connected by hinges, and so arranged that they can be folded together for transportation. When in use, the side panels are kept in place by two traverses, fitting into iron mortices. The frame work is placed on the floor of the car. At the four corners, four strips support a litter (FIG. 23), which is very similar to that above described, having a bed of reticulated girthing, a perforated foot-board, and sliding iron handles, and leathern loop handles also. The simple head pillow is replaced by a movable head rest, made like the bed of the litter



FIG. 23.—Baden swinging litter. [After LONGMORE.]

itself of interlaced webbing, and shifting by a rack movement. To moderate the lateral oscillations of the litter, two additional straps connect its sides with the side panels of the frame. The frame is so arranged as to serve a double purpose. When reversed, it affords a support for the litter, or constitutes a good camp bedstead, supporting the patient about a foot and a half above the floor. The use of swinging bars, in the transport of wounded by railway adopted in the system of Mr. Zavodovsky, as well in the Baden plan just detailed, and in a Prussian plan to be described hereafter, is esteemed by Professor Gurlt "an undeniable progress in humanitarian effort."\* Yet he fears that the straps by which the litters are hung are not suffi-

\* GURLT (E.) *Abbildungen zur Krankenpflege im Felde*, u. s. v. Berlin, 1868, S. 3.



ciently elastic, and would prefer india-rubber rings. Moreover, the sliding handles are slight and friable, the litters heavy, complicated and expensive, and ill-adapted to replace the ordinary field stretcher. As to the swinging litters in frames on the floor, they expose the patient to greater jarring than is experienced in the litters perched on bars, and are even more costly and complicated than the latter. Still the advantage they possess of being readily transformed into camp-bedsteads must not be overlooked. Like other special complicated litters, they cannot be adopted in large armies, where immense numbers of wounded are to be cared for; but may be advantageously employed in time of peace, or under special circumstances. FIGURE 24 gives an enlarged view of one of the corners of the Baden swinging litter, and enables the transformation of the litter into a camp-bedstead, by reversing the lower framework, to be more readily understood. With the extraordinary facilities afforded at the Paris Exposition of 1867, experiments were also instituted with the spring-stretchers of M. Gauvin, médecin-major in the French army. This stretcher is designed to be carried either by hand, or on wheels, or on the floors of transports of any description. Very favorable reports were made of the experiments conducted on the railway

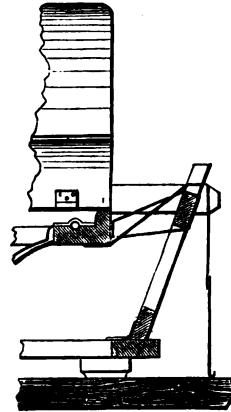


FIG. 24.—Transverse section of one corner of the Baden swinging litter. [After GURLT.]

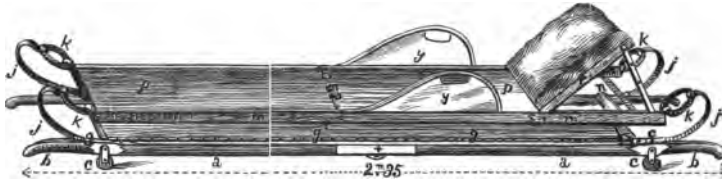


FIG. 25.—Gauvin's Spring Bed-Stretcher. [After GAUVIN.]

between Paris and Grenelle, to ascertain the adaptability of this stretcher to the transport of wounded in railway baggage cars. It was proved that the introduction or withdrawal of a stretcher with a man lying on it, was readily effected by three persons, while other stretchers required four or even six persons to handle them. The side wings and hand-rests (FIG. 25, *s. s.*) secured the patient on the narrow bed (the upper stretcher being 0 m. 52, or about 20½ English inches in width); the wooden rollers (*c. c.*) facilitated the introduction of the litter upon floors; the springs (*f. f. f. f.*) and rings (*k. k. k. k.*) afforded adequate elasticity; and the short handles (*b. b.*) limited the extreme length of the litter to 2 m. 35, or about 7½ feet. It was generally admitted

by the delegates to the international conference, that the spring stretcher-bed of Dr. Gauvin afforded a very easy mode of conveyance upon railcars unprovided with springs. So favorable were the reports that the French minister of war



FIG. 26.—Freight Car fitted up with eight Spring Bed Stretchers. [After GAUVIN.]

directed that further experimental trials should be made with this litter, and on January 20, 1868, a series of experiments were made † on the eastern railway in the presence of a Government commission of military surgeons, railway inspectors and others. Two mattresses, five bales of straw, and several Gauvin spring stretchers were placed in a freight car with stiff springs (*ressorts à patins*), which was attached, without tightening the coupling irons, to the end of a train running around the suburbs of Paris. It was unanimously agreed that the Gauvin litter was by far the most comfortable of the arrangements tried. A new hair mattress laid on five bales of straw was next in point of comfort, but permitted the vibration and jolting of the car to be felt. A straw mattress laid directly on the floor of the car was the most defective bed. The superiority of the Gauvin stretcher in loading and unloading was demonstrated. It could be maneuvered by two bearers, while a person borne on a mattress required four, and was subjected to much greater shaking and disturbance. In an experimental collision with a stationary train, by which the stretchers were rudely displaced, two requisite improvements were indicated, viz: means of keeping the stretchers steadfast in their places, and greater security in the connections between the upper and lower frames of the stretcher.

Another plan for the transport of wounded on freight-cars, employed on the Austrian Kaiser-Ferdinand-Nord-Bahn during the war of 1866, was exhibited at the French Exposition; but met with little if any approbation. On these Austrian covered freight-cars with four wheels, about twenty-five feet long and

\*Professor LONGMORE (*op. cit.* p. 467) states that "the persons who reclined upon the GAUVIN stretcher found their position very easy during the journey to Grenelle and back; so much so, that Baron LARREY and Professor GURLT, who, among others, tried the effect of the contrivance, were induced to say that the gently rocking movement caused by it had a tendency to lull a person to repose and even sleep."

†A full official report of these interesting experiments is printed in the appendix to the work *Conférences Internationales des Sociétés de Secours aux Blessés militaires des Armées de Terre et de Mer*, 2<sup>ème</sup> partie, Paris, 1867, p. 2, by MM. GAUVIN and SÉRURIER.

eight and a half feet wide, with a side door, sixteen upright posts were placed in fours, each set of four supporting (Fig. 27) two superimposed litters, provided with wedge-shaped pillows. Each litter is sustained by straps attached to the litter by one end and provided with strong iron rings at the other. Two of the straps of each litter are hung by hooks to the front or rear wall of the car, and two to the posts next the door. The straps at the head of the litter are placed obliquely from below upwards, and consequently draw the litter towards the front or rear wall. Where the litter abuts on the posts or ends of the car, the litter is slightly padded. To guard against accidents in case, from breakage of a strap, the upper stretchers might fall, two slats or laths are

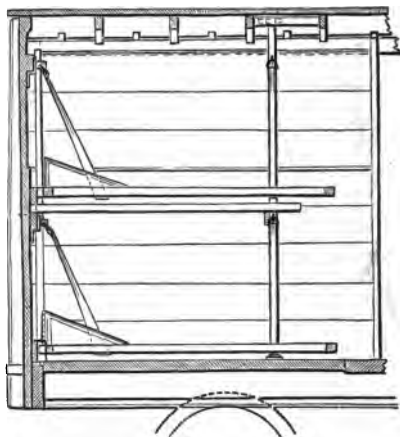
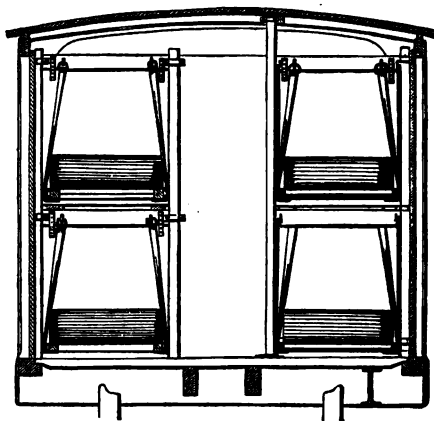


FIG. 27.—Longitudinal Section of a third of an Austrian freight-car, fitted up for the transport of recumbent patients. [After GURLT.]

secured lengthwise just beneath them to the posts, and serve also to facilitate the suspension of the litters. It was apparently the general impression among the delegates to the international conference that patients transported by this method must inevitably be exposed to great jarring and discomfort. The inelastic straps ill supplied the place of springs; the stretchers were without handles, and could not be lifted about easily; there were no protecting side rests; and the whole system was more complicated and less effective than those already discussed. It would appear that this system was not subjected to experiment.



The practical experiments with hospital cars at the Paris Exposition, and the discussions upon the various plans submitted there for transporting the wounded in war-time gave impulse to investigation and projects for the transport of wounded by railway, in various countries. Drs. Esmarch and Roth in Hanover, Drs. Loeffler, Gurlt, Virchow and Peltzer, in Prussia, Dr. Löwer, in Hamburg, Dr. Sigel, in Wurtemberg,

FIG. 28.—Transverse Section of an Austrian freight-car fitted up for transport of wounded. [After GURLT.]

Drs. Le Fort, Riegert and Gauvin, in France, Dr. Billroth and Baron Mundy, in Austria, Dr. Cortese, in Italy, Dr. Landa Y Alvarez de Carvalho, in Spain, either wrote upon the subject or urged it upon the attention of their respective governments. After the war against Austria, a commission instituted by the

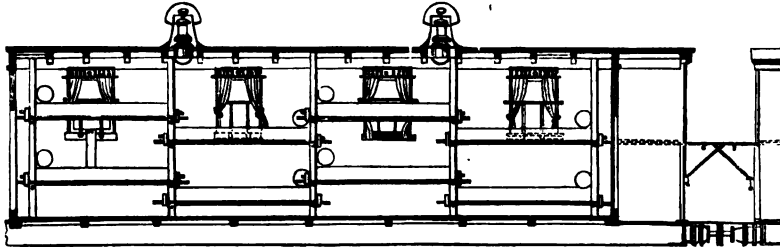


FIG. 29.—Hannoverian fourth-class car, fitted up for hospital use. [After ESMARCH.]

Prussian Government, in 1867, to report a plan of reorganization of the army sanitary service, resolved to ameliorate the transportation of wounded by railroads. It was at first proposed to utilize passenger cars upon the American plan. Professor Esmarch, of Kiel, a member of the Commission, earnestly advocated this system.\* He believed the fourth class passenger cars, which are constructed without seats, as well adapted for the purpose, if provided with end instead of side doors, and an arrangement for connecting the platforms (FIG. 28); these cars having as good springs as those of the first class.† This project was approved by the Prussian Minister of Commerce, who ordered that sixty fourth-class cars should be constructed on this plan. The German fourth-class passenger cars measure interiorly  $24\frac{1}{2}$  feet (English) in length,  $8\frac{1}{2}$  feet in width, and about (the roof is slightly arched)  $6\frac{1}{2}$  feet in height. By Dr.

\* In his *Verbandplatz und Feldlazareth*, Berlin, 1868, S. 35, Professor ESMARCH observes: "The United States Federal Government, which, at the instigation of the world renowned Sanitary Commission, organized the transport of wounded on railways so perfectly as to leave little to be desired, might well serve as an example to the European States in future wars." On page 39 he continues: "In the beginning, experts objected that such a system could hardly be introduced, since the German wagons were much smaller and lower than the American, and that intercommunication by doors at the ends of the cars, allowing free passage through the entire train, was impracticable in Germany, at least in compartment cars. But, when I laid the matter before Mr. von Unruh, the director of the great government manufactory of railroad material at Berlin, he declared, after mature deliberation, that it would not be at all difficult to arrange fourth-class cars, while in process of construction, in such a manner, that in case of war they could be used at once as hospital cars on the American plan. \* \* \* Director v. Unruh had the kindness to have drawings for such cars prepared for me (FIG. 29), and suggested that sixty new cars of class IV on this plan be built for the Hannoverian Railroads, a suggestion which was favorably acted upon by the Prussian Minister of Commerce. \* \* \* Should private railway companies follow this noble example, there would be sufficient accommodation for the transportation of wounded in the next war. As to the preparation of the necessary litters, it would appear to me to be a worthy undertaking for the voluntary aid associations to see to their preparation in times of peace, or, at least, to collect the necessary models, from which, on the outbreak of war, the requisite litters might be manufactured."

† ESMARCH (F.) (*op. cit.* S. 39): "Die Wagen vierter Klasse ruhen auf ebenso guten Federn, wie die übrigen Personenwagen."

Esmarch's plan eight litters were suspended on each side, and each car could convey sixteen patients. There was a passage way of  $3\frac{1}{4}$  feet between the lines of litters; and the folding end doors afforded a clear opening of 38 inches.\*

It was considered by the commission that it was essential that a system of railway transport of the wounded for general adoption should admit of the use of the ordinary field stretchers as suspended litters, and ultimately a plan was adopted which realized this advantage. The field stretchers of the Prussian army (FIG. 30) are 8 feet 9 inches long (English measure) and 23 inches wide. They are furnished with padded side-pieces 2 feet long and 6 inches high, to pre-

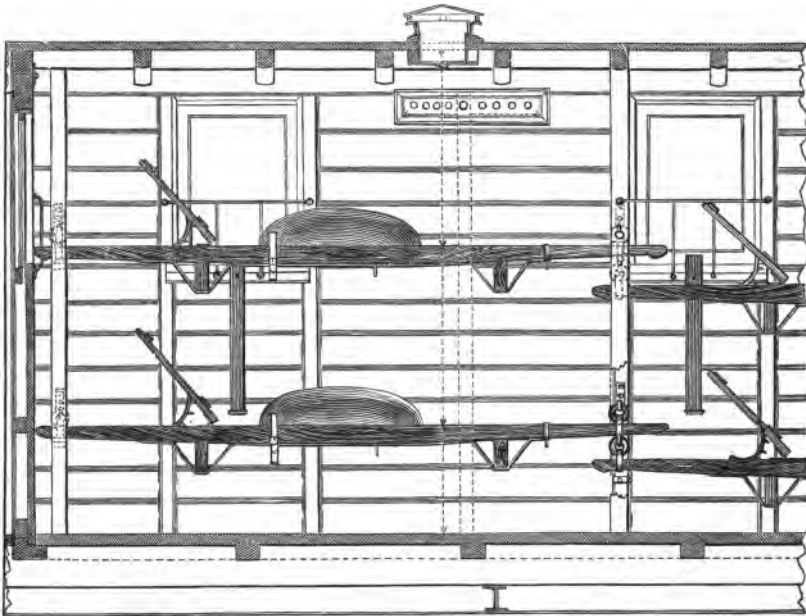


FIG. 30.—*Lateral view of the interior of part of a German fourth-class passenger car fitted with suspended field stretchers.* [After GURLT.]

vent the patient from rolling off, and with a hinged and folding back-rest, which can be placed at different angles of elevation. Twelve stretchers are suspended in a fourth-class car, six on each side, from sixteen upright posts, 3 inches square. To increase their solidity each of the eight centre posts is attached to its fellow side-post by iron bars (FIG. 31). All of the posts are furnished at suitable heights with iron hooks. The hooks are covered with leather, to diminish the

\*Subsequently this number, according to M. RIEGERT, (*Des Wagons-Ambulances*, in *Recueil de Méd. de Chir. et de Phar. militaires*, 1872, Vol. XXVIII, p. 197) was increased by 40, and 100 old fourth-class cars were altered to conform to this plan. Therefore the Germans, at the outset of the Franco-German war, as Professor VIRCHOW (*Der Erste Sanitätszug des Berliner Hilfs-Vereins für die Deutschen Armeen im Felde*, Berlin, 1870, S. 4) informs us, had 200 cars in readiness for hospital use.

friction and wear of the caoutchouc rings that hang upon them. Through the rubber rings are passed leather rings which encompass the handles and sustain the stretchers. On account of the great length of the stretchers, those in the middle sections are hung at a different elevation from those in the end sections. The lower litters of the end sections are 18 inches from the floor, those of the middle sections 11 inches. The upper litters are about 4 and 3½ feet respectively from the floor. These distances permit the patients in each series of litters to raise the upper part of the body, and even to sit upright. Ventilation

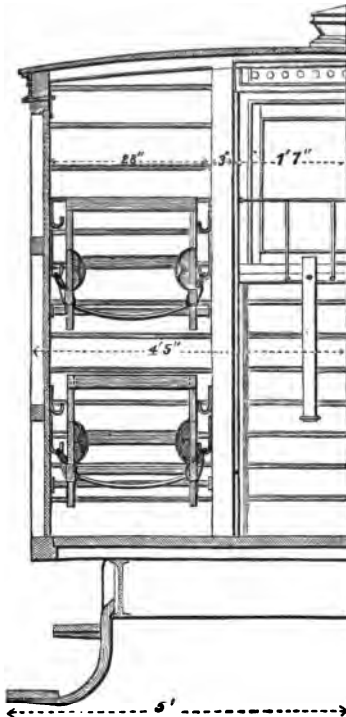


FIG. 31.—End elevation of half of a North German fourth-class car, arranged as in the preceding cut. [After GURLT.]

is provided for by ten windows, four on each side and one at each end, and by three ventilators in the roof. At night a lamp is placed in each ventilator. When very hot and draughts of air are dangerous, the windows may be closed and the rear door opened, a measure that answers very satisfactorily. In order to load the cars it is necessary to separate them ten or twelve feet. Four men are needed to lift a loaded stretcher and to place it in position. "Experiments in this system," Professor Gurlt remarks, "have demonstrated that if the stretchers, especially those of the upper tier, are subjected to oscillations during the journey, the caoutchouc rings completely obviate (völlig ausgleichen) vibrations and shocks, which is not the case in a system of suspension by straps and cords. The fourth class wagons described are adopted in Prussia by order of the Minister of Commerce. They offer many advantages for the transport of wounded men. They are

well lighted and well ventilated; the patients lie in them commodiously and suffer little from jolts; the beds are accessible, owing to the width of the passage which extends through the entire length of the wagon; consequently dressings can be made with all desirable regularity; the wagons are connected by drawbridges, and this permits supervision of the wounded and the arrest of accidents, such as those caused by hæmorrhage, etc., and the number of hospital attendants can be lessened. The method of suspending the litters is preferable to the American plan, which served as its model, since the side poles of the stretchers cannot strike against the posts, as in the other." Dr. Gurlt goes on to comment on the system of converting fourth-class

cars. "To make the system complete, however, a special car is required, joined to the others by platforms and drawbridges. This car would be assigned to the sanitary personnel. Here the attendants could wait and repose, could store and prepare food, refreshments, medicines, dressings, instruments, etc. Passenger cars on the system in common use in the north of Germany are altogether unsuited to this end. They do not afford the necessary space for the objects that should be kept on hand or prepared; their doors opening on the sides, the persons conveyed on them can communicate with the other cars only at the railway stations. The organization above described, on the other hand, permits the attendants who accompany the train at all times to exercise an efficient control, and to render each other mutual aid." Staff-surgeon Wilhelm Roth,\* in 1868, described and figured the Hannoverian fourth-class car, converted to hospital purposes on the above system, in much the same terms as Professor Gurlt, mentioning, however, that rubber pads were interposed between the end handles of the stretcher poles and the end walls of the cars, and also that the windows were opened by revolving upon a central vertical iron bar, thus permitting the admission of air without a direct draft on the patient, and remarked that the same system could be readily applied to all box freight cars: "Compared with the excellent American system, this has equal simplicity and can be more readily improvised." It is claimed that the rubber-rings deteriorated less readily when attached to leathern straps than when hung directly on wood or iron,† and that almost any form of field-stretcher can be slung upon the poles. The cars are well aerated, and well suited to the circumstances likely to be required in time of war.

As supplementary to the conversion of fourth-class passenger cars to hospital purposes, the Prussian commission recommended a plan for fitting up covered freight cars. The box-cars in north Germany are 20 (Rhenish) feet in length (about 20½ feet English) and 7 feet 8 inches in width. Those employed for transporting cattle are provided with iron staples and rings (FIG. 32, *a, a*) along the sides, which are connected with transverse swinging poles, finished at the ends with iron caps and projecting rings. The swinging poles are usually chained to the side-rings; but the mode of connection is altered when the car is used for sick-transport. Then the poles are swung by massive caoutchouc rings (*b, b*) secured to the iron side and pole rings by straps with buckles (*c, c, c, c*). Eight poles

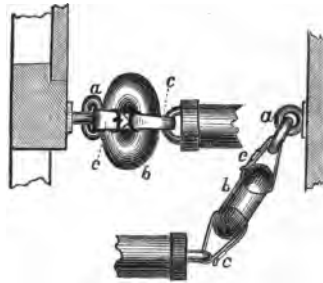


FIG. 32.—Method of coupling swinging poles in German freight cars. [After GURLT.]

\* ROTH (W.) *Militärärztliche Studien*, Berlin, 1868, S. 25, und Tafel I, FIG. 5.

† LONGMORE (T.) *A Treatise on the Transport of Sick and Wounded Troops*, p. 460.

are swung transversely in pairs, a pair at either end of the car and a pair from the posts at each side of the side doors. The side rings for the lower poles are 18 inches from the floor, and these poles swing at about 7 inches from the floor; the upper rings and pole are 50½ inches higher (FIG. 33), so that there

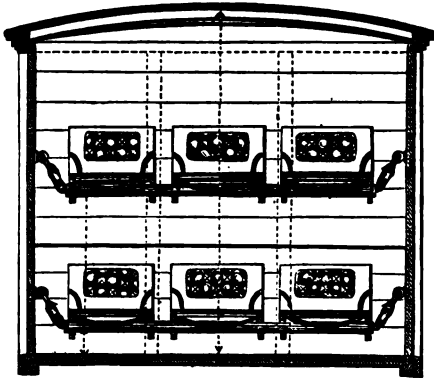


FIG. 33.—Transverse section of a Prussian box-car, with suspended litter. [After GURLT.]

is room for the patients in each tier to sit upright. On each pair of poles three stretchers of almost any description can be hung. The cost of furnishing a freight car by this method including the cost of iron and caoutchouc rings, of straps and buckles,\* and of poles, is 80 thalers, or about \$60. Dr. Gurlt remarks that the advantages of this plan over the somewhat similar Baden or Fischer system

(FIGS. 21, 22, 23, pp. 25, 26) consist chiefly in the substitution of elastic rubber-rings for straps, the utilization of the horse-poles, and, lastly, the practicability of using almost any form of field stretcher. Moreover the car conveys twelve patients instead of eight. The disadvantages are obvious. Two layers of wounded occupy the

complete width of the car. As the Prussian field stretchers are 8 feet 9 inches long, and as the ends of the poles cannot be placed safely at less than 6 inches from the ends of the car, there remains a space of 18 inches only in the middle of the car, for the nurses to move in. However, the width of the car is sufficient to permit a person to approach the side of one of the stretchers, when the other two on the same poles are pushed close together (FIG. 34). The ventilation of the cars arranged on this plan, according to Professor Gurlt, proved very defective.

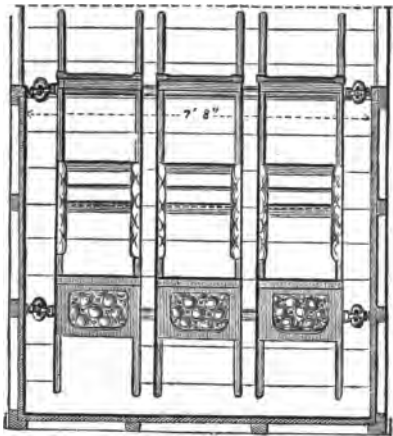


FIG. 34.—Horizontal plan of nearly one-half of a north German freight car fitted with stretchers on swinging poles. [After GURLT.]

As early as 1866 a Spanish military surgeon, Dr. Nicasio Landa, devoted a considerable portion of an interesting paper on the transportation of the wounded in war to the subject of railway transport. As the passenger cars in



Spain are divided into compartments, Dr. Landa designed\* to fit up freight-cars with upright posts and superimposed litters suspended by elastic rings. The

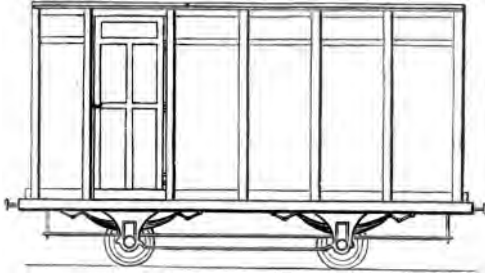


FIG. 35.—Exterior of a Spanish box-car.  
[After LANDA.]

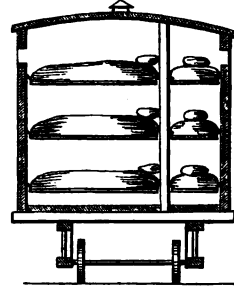


FIG. 36.—End section of the same with litters. [After LANDA.]

position of the side doors in the Spanish box-cars (FIG. 35), which are of about the same dimensions as the German cars of the same class, permitted six

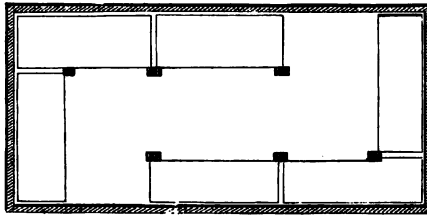


FIG. 37.—Horizontal plan of the preceding  
[After LANDA.]

tiers of litters to be placed with sufficient intervening passage-way (FIG. 37). Thus eighteen berths were provided in each car, though necessarily in very close contiguity. This is a very ingenious arrangement, although the number of occupants is much too great for the cubic capacity of the car. Only

six upright posts were required. The stretchers were attached to these and to the sides of the car by means of iron hooks and strong elastic rubber-rings

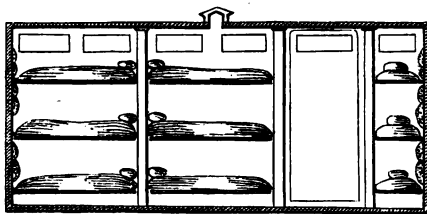


FIG. 38.—Lateral view of the preceding.  
[After LANDA.]

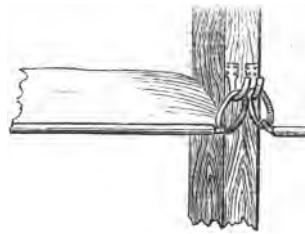


FIG. 39.—Mode of suspension of litters in Dr. LANDA's project.

(FIG. 39). Whether this system has been submitted to experimental trials,

\* LANDA (D. NICASIO Y ALVAREZ DE CARVALLO) *Transporte de Heridos y Enfermos por vías ferreas y navegables*, Madrid, 1866, p. 52, et seq. Dr. LANDA is an ardent admirer of the plan proposed by Dr. HARRIS: "Este hombre benéfico era el Dr. Elisha-Harris, afamado práctico de New York, y uno de los fundadores de la poderosa Comision Sanitaria de los Estados-Unidos: á él corresponde la gloria de haber inventado los wagones hospitales."

and what inconveniences might result from the close proximity of the berths to the sides of the cars and to each other, has not been made known in this country, though Dr. Harris informs me that the plan has been adopted in Spain.

Dr. A. Sigel has described \* the mode of suspending litters in freight-cars and passenger-cars without seats adopted in the Wurtemberg hospital railway trains. It was a very simple and inexpensive arrangement (FIG. 40). Field stretchers furnished with mattresses were suspended in pairs from the sides of the car by strong hempen girthing, and pads were interposed between the outer poles of the stretchers and the sides of the car. Dr. Sigel regards this as the best plan in use during the Franco-German war, remarking that the girths never broke, and were not in the way when the car was used for freight,



FIG. 40.—Part of a Wurtemberg hospital car.  
[After SIGEL.]

and that the patients experienced but little jolting. This is surprising, as the girth webbing could have but little elasticity; but Dr. Sigel is a staunch advocate for this mode of suspension, and observes that his experience with caoutchouc rings was very unsatisfactory, as they were found to yield excessively and very unevenly when placed on the stretch. Moreover, Conductor Wasserfuhr, of one of the Prussian hospital trains, admitted to him that several of the rubber-rings, and even one of the leather straps on his train, had broken, and rendered it necessary to place iron safety-bars beneath the upper litters. Professor Esmarch commends the Wurtemberg hospital trains because end doors were uniformly placed in the cars.

Surgeon-in-Chief Löwer has printed an article on the value of the Hamburg hospital trains, composed of covered freight wagons. On leaving Hamburg the train consisted of three or four cars—a passenger car, containing the *personnel*—and box-cars filled with bedding, stoves, cooking and eating utensils, chests of bandages and appliances, medicines, and provisions,—material for one hundred and sixty patients. On the route

\* SIGEL (A.) *Die Württembergischen Sanitätszüge in den Kriegsjahren 1870 und 1871*, Stuttgart, 1870, SS. 20, 37. A detailed account is given of the *personnel* and *matériel* of a hospital train, which consisted of fifteen carriages, including a store-car, a commissary-car, a kitchen-car, a car for officers, a car for attendants, two for slightly wounded, and eight for severely wounded.

as many empty freight cars were taken on as the locomotive could draw, and these were fitted up, while the train was in motion, from the material on the store-cars. The mode of suspension was devised by Herr Hennicke, an engineer of Hamburg, and consisted of a strong iron claw, tightened by a screw

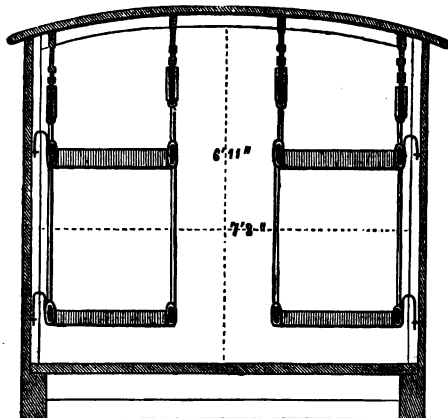


FIG. 41.—End section of a Hamburg car fitted for hospital use. [After LÖWER.]

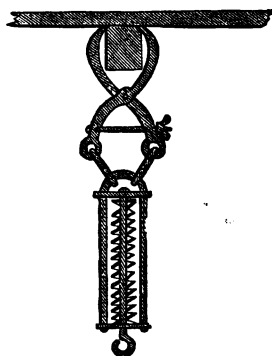


FIG. 42.—Devils-claw and spiral spring used on the Hamburg hospital cars. [After LÖWER.]

bolt (FIG. 42), which secured the claws to the rafters of the car (FIGS. 41, 42). The claw was connected with a powerful spiral spring, to which was attached a rope with loops in which the litters were swung. Each set of four springs and

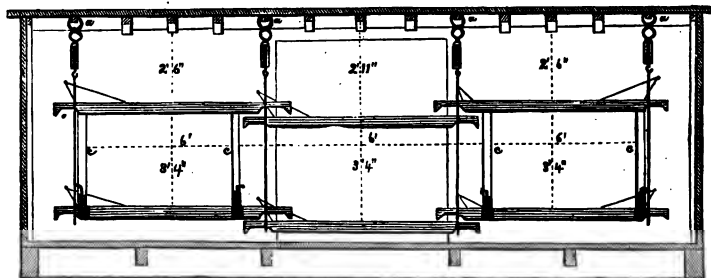


FIG. 43.—Lateral section of a Hamburg freight car converted to hospital use. [After LÖWER.]

ropes supported a pair of litters, the space between the upper and lower litters being 3 feet 4 inches. For security, in case of accident, wooden bars (FIG. 43, c, c, c, c) were placed between the upper and lower litters. To prevent transverse swaying, steel C-springs (FIG. 41) connected the poles of each litter with the sides of the car. The stretchers were wooden frames covered with canvas, 6 feet 1 inch long, and 30 inches wide. They could be rolled up

\*LÖWER. *Ueber den Werth der Hamburger Sanitätszüge in Deutsche Militäirärztliche Zeitschrift*, 1872, B. I, S. 143.

after the removal of both end traverses. A small freight car conveyed eight, and a large one ten or twelve patients. Dr. Löwer vouches for the security and comfort of this arrangement from actual experience in war; and claims that it has the advantage of being applicable to any cars that are without seats or partitions. In Dr. Wittelshöfer's beautiful series of photographs\* of the hospital material exhibited at the Vienna Universal Exposition of 1873, the Hamburg hospital car is represented with sliding side-doors. Staff-surgeon Peltzer,† of Berlin, observes: "It cannot be denied that this system of suspension, notwithstanding the advantages of elasticity, is too complicated to be readily repaired in case of accident, or to be made use of in cases of emergency; and, to say the least, it has a suspicious look regarding the safety of its application," and suggests that the constructors of the above system were



FIG. 44.—Method of suspending swinging poles in freight-cars commended by M. LE FORT. [After LE FORT.]

impressed with the latter idea, as, generally, safety props are added to the already complex apparatus, to give additional security to the suspended litters. Another objection to this mode of suspension is that the roofs of the freight cars are hardly ever sufficiently strong to support such a number of litters and patients with safety.‡

In France there was but little opportunity during the late war for the systematic transport of wounded by railway; but several military surgeons paid much attention to the subject, especially M. Gauvin, whose admirable contrivances have been noticed (p. 26), MM. Legouest, Riegert, Morache and Le Fort.|| The latter proposes that, in time of peace, each railroad company should have at least a hundred freight-cars provided with wide end doors and platforms arranged as drawbridges. The doors could be closed and the platform bridges drawn up except where the cars were converted to hospital use. M. Le Fort objects to the mode of suspension by caoutchouc rings, on the ground that it is necessary, in order that they should be safe, to make the rings of a thickness that

\* WITTELSHÖFER (L.) *Die Freiwillige Hilfe im Kriege und das Militär-Sanitäts-Wesen auf der Wiener Weltausstellung*, 1873, Tafel XXV.

† PELTZER (M.) *Die Deutschen Sanitätszüge und der Dienst als Etappen-Arzt im Kriege gegen Frankreich*, Berlin, 1872, S. 27.

‡ It was stated that after the capture of Metz, long trains of cars fitted up on this system were used as stationary hospitals for the wounded of BAZAINE's army. One side door was closed, and wooden steps were built at the opposite door. This novel form of field hospital answered the purpose remarkably well.

|| LE FORT (LÉON) *La Chirurgie militaire et les Sociétés de Secours en France et à l'Étranger*, Paris, 1872, p. 148, et. seq.

annihilates the elastic property of the caoutchouc. He believes that spiral steel springs and hooks (FIG. 44) might be advantageously substituted as the means of suspension.

The war of 1870-71 surprised the French War Department without an organized system of railway transport for the wounded. It was not until July 19, 1870, that an "intendant", M. Robert,\* was instructed to arrange with the Eastern railroad company with reference to this subject. The constructors of the company showed great zeal and activity, and it was expected that an adequate number of cars would be provided by their work-shops at Montigny, near Metz. But all this rolling stock was locked up when the Germans invested Metz.† On December 25, 1870, the republican ministry made another effort, and ordered hospital railway trains to be fitted up for 1200 wounded. A few were organized, and rendered signal service, the wounded of General Chanzy's army, especially, having been promptly removed by rail.‡ After Sedan, many thousands of the French wounded are said to have been carried off on the cars at the Northern railway, without stretchers, or any special outfit.

Generalarzt F. Loeffler|| altogether approves the outfit for the transport of wounded, adjudged the most suitable for freight-cars by the Prussian Commission of 1868. This plan was devised by Mr. Grund, a master-machinist, and consisted in supporting three field-stretchers in the front and three in the rear part of the freight-cars (20 feet long), by means of transverse wooden bars (FIG. 45) resting on semi-elliptical plate springs (FIG. 46). The springs are spiked at one end to the flooring to keep the bars stationary, while at the other end are rollers to permit the yielding of the springs. The latter are surmounted by U-pieces, or clips, to receive the cross-bars. Four cross-beams and eight springs constitute the outfit requisite for the reception of six

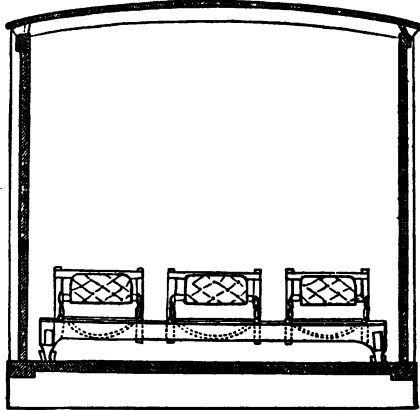


FIG. 45—End section of a part of a freight-car fitted with Grund's system of stretchers on springs [After LOEFFLER.]

\* ROBERT (C.) *Difficultés que rencontre en France l'administration des grands armées, et moyens pratiques d'y remédier* Paris, 1871, p. 16 in *Journal des Sciences Militaires*, 1872, p. 161.

† And probably constituted the long hospital trains that Dr. PELTZER saw at Metz, used as stationary hospitals for the French sick and wounded.

‡ The circulars are printed in full in the *Journal militaire officiel*, 1871, § 158, 176, and in the *Annales d'hygiène*, 1871, T. XXXVI, p. 190. Seven trains were ordered with termini at Brest, La Rochelle, Bordeaux, Bayonne, Besançon, Marseilles, Nice, Toulouse, etc.

|| LOEFFLER (F.) *Das Preussische Militär-Sanitätswesen und seine Reform nach der Kriegserfahrung von 1869*, Berlin, 1869, B. II, p. 251.

litters; and cost 24 thalers, or about \$18. Dr. Loeffler highly commends this plan as simple, inexpensive, and comfortable, and as of ready adaptation to fourth-class

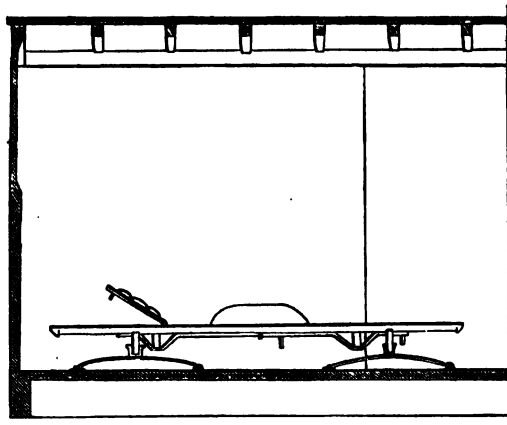


FIG. 46.—Longitudinal section of a part of a freight-car arranged on Grund's system. [After LOEFFLER.]

cars. The litters represented in the cuts (FIGS. 45, 46) are the ordinary Prussian regulation field stretchers; but the system admits of the use of stretchers of almost every description. Dr. Loeffler justly observes that this plan, in common with almost all systems of railway transport of the wounded, demands a very large increase in the number of stretchers to be supplied to an army

in the field. He strongly objects to all methods that tolerate superimposed litters,\* and condemns the use of india-rubber wares, as notoriously liable to become hard and friable. He thinks that spiral springs may possibly replace advantageously caoutchouc rings, as a method of elastic suspension. Four very complete hospital railway trains attended the two Bavarian army corps that participated in the war of 1870-71. They are described by Constructor Hirschberg in an extended treatise,† in which no allusion is made to the Prussian origin of the method of supporting the litters. The order for the preparation of the four trains was issued July 18, 1870, and the first train left for Weisseimbourg August 7, 1870, and consisted of 1 first-class, 4 second-class, 15 third-class passenger cars and 20 freight cars. Experience proved that this train was too long, and, eventually, the trains were made up with 29 cars, 7 second and third-class passenger cars heated by steam, for the less grave cases, 13 passenger cars fitted up for recumbent patients, a car for the surgeon and assistants, a spare car for emergencies, a platform car for fuel, and 6 freight cars, one fitted as a kitchen, one carrying the steam heating apparatus, and four the stores, appliances and other material. The trains made altogether 39 trips, transporting 10,800 patients. The Bavarian passenger cars were short, with

\* LOEFFLER (F.) (*Op. cit.*, p. 250) "The laying of patients one above the other, in the American cars, in three tiers even, is assuredly not a means of promoting the anything but comfortable condition of wounded men on long railway journeys. The inconveniences inherent in such plans have proven so considerable, especially in the attempts to place twelve wounded in two tiers on freight-cars, that such experiments must be abandoned."

† HIRSCHBERG (R.) *Die bayerischen Spitalzüge im deutsch-französischen Kriege, 1870-71*, München, 1872. Sn; 98, mit 12 Tafeln. Dr. M. PELTZER also (*Die Deutschen Sanitätszüge*, Berlin, 1872, p. 9) describes these trains.

five windows on each side and end doors, of insufficient width to admit stretchers, and end platforms. They were provided with 5 beds, 3 on one side and 2 on the other (FIGS. 47, 48), leaving a space for a stove and table. The beds were supported by a modification of the Grund system, that is, on semi-elliptical

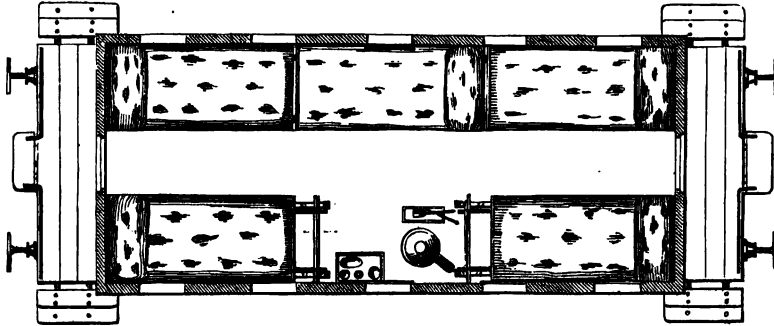


FIG. 47.—Horizontal plan of a Bavarian hospital car. [After HIRSCHBERG.]

springs, secured as in the Prussian plan approved by Dr. Loeffler, but raised higher from the floor by vertical boards resting immediately on the springs. The upright planks were notched at the top to receive the side poles of field stretchers or camp bedsteads, supporting thick hair mattresses with wedge-shaped pillows. A board standing upright by the lower third of each window protected the patient from cold draughts, and served as a tray at meal times.

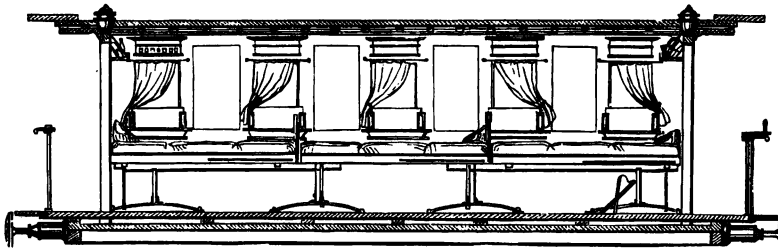


FIG. 48.—Lateral section of a Bavarian third-class car transformed for hospital use. [After HIRSCHBERG.]

The Bavarian freight cars were fitted with camp bedsteads supported in like manner, two at each end of the car, on frames resting on springs (FIG. 49). One of the wide side-doors of the car was kept closed, and the other doorway was provided with a gang-plank, with cross slats. After loading the car, this plank could be laid transversely in the middle of the car, with the slats downwards, and be made to serve as a platform for a fifth pallet, without springs, still leaving space by the closed door for a bench for the attendant. The freight cars were very inferior in point of comfort to the converted third-class passenger cars, as they did not communicate with the rest of the train, and

were not heated. The Bavarian trains usually conveyed 250 patients; but sometimes as many as 566, and, on one occasion, after Reischaffen, Train No. 2 transported 870 patients to Haguenau.

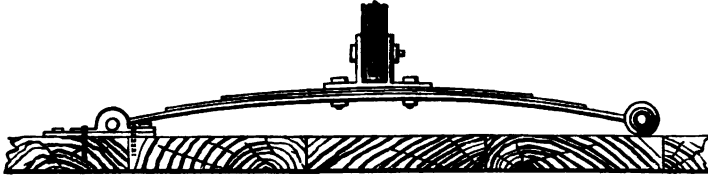


FIG. 49.—Enlarged view of the spring used in Grund's system and adopted in the Bavarian trains for the support of the litters. [After HIRSCHBERG.]

Towards the close of the Franco-German war, the Germans are said to have employed 21 hospital railway trains to convey their sick and wounded homewards, viz.—9 Prussian, 4 Bavarian, 2 Wurtemberg, 1 Rhenish (from Cologne), 1 Hessian (from Mayence), 1 Saxon, 1 Hannoverian, 1 Hamburg and 1 Baden train. The 21 trains afforded accommodations for 3724 recumbent patients. The cost of fitting up the trains averaged 2900 thalers each, or \$2200. They were organized partly by the War Office, partly through the efforts of voluntary aid societies. The government accepted largely the assistance offered by the latter, both of material and men; but reserved the right of absolute control over both; so that, as in the United States, the hospital trains were under strict military rules.

The Prussian trains were made up on the average of about 27 cars, comprising 20 hospital cars, a saloon car, a passenger car, a provision car, a kitchen car, 2 baggage cars, a platform car for fuel. The sick cars were generally the converted fourth-class passenger cars from the Hannover lines, only instead of placing in them 12 or 16 litters, there were rarely more than 10, suspended in two tiers, 6 litters on one side and 4 on the other, leaving a free space in the middle of one side for a stove and table. There was a wide passage-way with end doors. The floor was covered with oil-cloth, or, during the severe cold weather, with matting. The beds consisted of field stretchers covered with thick hair mattresses, with pillows, sheets and blankets. The stretchers, in some cars, were suspended to stanchions by rubber rings (Figs. 30, 31), and in others rested on springs on the floor, arranged on Grund's system. Mr. Wasserfuhr,\* the director of the Prussian hospital train No. 5, approved warmly of the method of suspension by rubber rings. He admits that four or five rings broke; but no serious accident resulted.

The Saxon hospital train was composed of 19 freight cars transformed for 8 beds, 3 fourth-class passenger cars fitted on the Grund system, a kitchen car,

\* WASSERFUHR. *Vier Monate auf einem Sanitätszuge in Vierteljahresschrift für öffentliche Gesundheitspflege*, also translated by M. MORACHE in *Annales d'hygiène publique et de médecine légale*, 1872, Vol. XXXVII, p. 241.



a store car, a baggage car, and a platform fuel car. It could transport 182 patients; but was defective in having no accommodations for the attendants.

The Baden train consisted of 2 first and 2 second class passenger cars for seated patients; a kitchen and store car, a saloon and a sleeping car for attendants, 14 cars for recumbent patients, some fitted up on the Heidelberg plan described at page 25, and others borrowed from the Wurtemberg lines. About 220 seated and 140 recumbent patients could be carried.

The mode of outfit on the two Wurtemberg trains has been described on page 36 (FIG. 40). The train was provided with kitchen, provision and store cars, and a car for the attendants, and could carry 160 wounded. In 22 trips, they actually carried 4303 patients, and traversed 4197 miles of track.

The Rhenish train, from Cologne, was made up of 3 passenger cars for seated patients, a saloon car, 3 cars for attendants, 3 for provisions and cooking, and 16 freight cars of 8 beds each, of litters suspended by rubber rings. It could carry 152 recumbent and 96 convalescent or slightly wounded patients. The Hessian train, from Mayence, was similarly organized, carrying slightly wounded as well as recumbent patients, the latter in 20 box-cars, each with litters, suspended in two tiers.\* Many of the trains moved without changes from the scene of action to Berlin† or other remote points. Many eminent civilians volunteered their services, among them the celebrated Professor Virchow.‡

\*Dr. PELTZER (*Die Deutschen Sanitätszüge*), from whom many of the foregoing details are quoted, states that there were three main routes, that by Nancy being the most used. Over this line, August 23, 1870, to May 5, 1871, 144,940 sick and wounded were transported, of whom 17,385 were transported on 83 trips of the sanitary trains; the remainder being carried on ordinary trains.

†Dr. STEINBERG (*Die Kriegslazarethe und Barracken von Berlin*, 1872, p. 15) states that 26 hospital trains arrived in Berlin from September 28, 1870, to May 19, 1871, bringing 3255 patients.

‡VIRCHOW. (*Der Erste Sanitätszug des Berliner Hilfs-Vereines*, Berlin, 1870, S. 34) commemorating the arrival in Berlin of the hospital train under his direction, with 130 patients, remarks: "For the first time were severely wounded men transported by us hundreds of miles, directly from the field of battle until they reached their homes, securely and well attended. On the same litters on which they were placed into the wagons at Ars and Novéant, they had made this long journey; they were transported on these same litters without re-shipping, and brought in the railway cars up to the gates of the hospitals; and, lastly, on the same litters, always, they were carried into the hospitals to their beds." Professor VIRCHOW would have been more exact had he said, as he doubtless meant, that this was the first train of sick and wounded fitted out by the Berlin Aid Society that reached Berlin (Oct. 13, 1870). Two trains, however, the Wurtemberg Sanitary train, and the first Sanitary train of Mr. v. HÖNKA, a Silesian nobleman, had preceded that directed by Professor VIRCHOW, arriving in Berlin respectively on September 28, and October 10, 1871. Professor VIRCHOW makes some most interesting observations on the condition of some of the patients after their journey: "In reality," he says "the condition of many sick improved visibly during the time of transport. Of the wounded who, at the same time suffered from dysentery, many experienced a decided improvement. Especially apparent was this in two patients from Pont à Mousson, whose surgeon already at Frouard requested to have them left at Nancy, one as moribund, the other suffering from (fresh) erysipelas of the face. With tears in their eyes, both patients begged to be taken along. I could not refuse them. I not only brought them safely, but in a much ameliorated condition to Berlin;" and at page 29, he adds, "and I was not a little astonished, as, a few days after our arrival at our barracks, which are certainly fitted up with some degree of care, all the wounded unanimously declared, that they did not lie as well here as in the train."

Dr. Morache, adjunct-professor of the French School of Military Medicine, and author of an essay on the various methods of railway transport of sick and wounded, has proposed a plan for the outfit of cars for sanitary purposes, selecting the method commended by Dr. Loeffler as the best provision for litters resting on the floors of cars; but adding a superimposed tier of litters suspended from a tubular iron rod near the roof,\* by iron rectangular frames connected

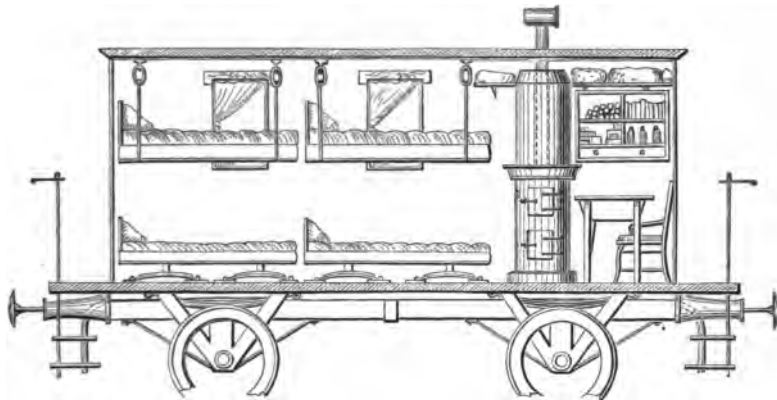


FIG. 50.—Project for the conversion of the Lyons freight-car to hospital use [After MORACHE.]

with the rod by "gutta percha." After referring to the assertion of French engineers that long cars are impracticable on their roads, abounding in short curves, and declaring that it is preferable on the score of economy to use freight rather than passenger cars, M. Morache submits a project for placing litters for ten patients in the box-cars and on the six principal French lines. These cars vary in interior dimensions from 18 to 21 feet in length by 7 feet in breadth.† The litters are only 1 m. 75 in length by 0.75 in width. Six are placed, in two ranges, on one side of the car, four only on the other side leaving a space reserved for a stove, chair, table, and set of shelves (FIG. 50). The litters are complex, consisting of a light lower frame, resting on the

\* MORACHE. *Les Trains Sanitaires; Etude sur l'emploi des chemins de fer pour l'évacuation des blessés et malades en arrière des armées*, Paris, 1872. This work gives a comprehensive review of the whole subject, and I regret that I did not meet with it until this report was nearly completed. It contains many interesting details, especially in regard to the work performed by the German hospital trains during the Franco-German war. The project for the conversion of French passenger and freight cars to hospital use has, however, obviously never been subjected to practical trial, else M. MORACHE would never have recommended the suspension of litters by *gutta-percha* rings. He has been misled by Professor HAMILTON (*op. cit.*, p. 168), into the statement that this brittle substance was used for suspension rings in the American hospital cars. It is hardly necessary to remind the reader that *gutta-percha* is the inspissated juice of the *Isenarda Percha* or *I. Gutta* (Hooker) and that the vulcanized rubber rings used in the United States and in Germany were of caoutchouc, a product of several species of the genera *Siphonia*, *Hevea*, *Jatropha* and *Ficus*, and though somewhat resembling *gutta-percha* in chemical constitution, widely differing in its physical properties.

† M. MORACHE gives the exact measurements: The freight cars of the railway du Midi: 6 m. 45 in length, 2 m. 5 in breadth and 2 m. 45 in height. Those of the railway de Lyon are 5 m. 5 in length, by 2 m. 5 in breadth and 2 m. 4 in height.

springs or suspension rods, and receiving an upper frame, over which canvas is stretched. On this frame rests a mattress and triangular pillow, the former fastened to the frame by tacks. The upper frame is bolted to the lower, and is furnished with eight long loop-handles, arranged in pairs on the sides and ends. The lower litters rest on traverses let into mortices upon four semi-elliptic springs, on the Grund system. The suspended litters are attached by wrought iron quadrangular frames to a horizontal tubular iron rod, by the intervention of thick "gutta-percha" rings. As the rings would rapidly wear if in direct contact with the iron, there are interposed, both on the frames and transverse bar, spools of hard wood over which the loops are passed. The passage-way and folding doors at the end are over three feet wide. The latter are glazed at the upper part, and two windows are pierced on either side. The stove, and oil-lamp in the ceiling, are made to conduce to ventilation.

At the Vienna Exposition of 1873, an international conference of military surgeons and sanitarians was convoked, on October 6th-9th by Dr. Wittelshöfer, Professor Billroth, and Baron Mundy, for consultation and practical testing of the models for appliances for the transport of wounded in war. The second day of the conference was devoted to a discussion on railway transport, and an excursion on an hospital train to Vöslau, where Professor Billroth had provided a banquet. The details of outfit of passenger and freight cars were debated by the eminent experts who attended the conference. Dr. Roth has described the models that were exhibited, and most of them are represented in superb photographs prepared under Dr. Wittelshöfer's supervision.\* Dr. Roth observes that "the various experimental trips afforded a ready means of studying the different methods of railway transport, although the German suspension systems and the stationary system of the French trains could not be fairly compared, as many of the cars were exhibited only as models; but it was possible to ascertain many important facts. The excellent ventilation of the French cars, with roof-lanterns, was particularly remarked; the aeration of all the others was very defective. As to the litters or couches, except the Hamburg plan, which admitted of severe swaying, there was but little difference in the several plans. There were exhibited small models only of the Prussian, Schleswig, and Baden hospital cars, but full-sized patterns of the car for wounded and surgeon's car of the Palatinate train, of the kitchen-car, provision-car and car for wounded of the Bavarian trains, of the Hamburg car for wounded, and of hospital, kitchen, and refectory cars of the French aid-society.† From practical experience in war, as well as from observation of the working

\* ROTH (W.) *Einige Versuche über die internationale Privatconferenz zu Wien von 6 bis 9 October, 1873*, in *Deutsche Mil. Arzt. Zeitschrift*, 1873, B. II, S. 655. WITTELSHÖFER (L.) *Die Freiwillige Hilfe im Kriege und das Militär-Sanitäts-Wesen auf der Wiener Weltausstellung, 1873*.

† The latter were built by Superintendent C. BONNEFOND, of Ivry, from specifications by Baron MUNDY and M. LEON, constructor of the Lyons railway, and were designated "New model of 1873."

of the cars exhibited on this occasion, Professor Billroth concludes that stationary beds, or "complete fixation of the litters, in a technical view, is the simplest and most substantial system, causing the patient the least detriment, provided he rests upon a good mattress, in a car with easy springs." As a means of easing the stiff steel springs of freight cars, Professor Billroth suggests the removal of alternate leaves of the springs, which may be accomplished, in less than an hour for each car, by two skilled workmen, as was demonstrated at a car factory at Simmering near Vienna.\* Indeed, the eminent professor appears inclined to discountenance almost any outfit of hospital cars that cannot be promptly improvised.† The fact announced by Dr. Peltzer, that, in the Franco-German war, about an eighth only of the sick and wounded removed by railway, had been conveyed on special hospital trains, made its impression.

It was the general sentiment that those sanitary trains would be most useful that could be readily fitted up with material likely to be found on hand near the scene of conflict; and that the most convenient mode of utilizing the existing material of supply trains should take precedence of all others.

In March, 1873, the Russian government appointed a commission for the discussion and experimental trial of different methods for the amelioration of the condition of sick and wounded soldiers transported on railroads.‡ Major General Annenkopf, president of the commission, requested the different railway companies to send to St. Petersburg cars of different classes, fitted up according to their own designs, but with material supplied by the government, with cross-beams or stanchions, with hooks, rings, straps, litters, etc., the different methods of outfit to be submitted to competitive examination. In accordance with this request seven railroad companies sent passenger cars converted for hospital use and one company provided a box-car fitted for the same purpose. A train was formed of the eight cars, for the transport of three hundred and thirty persons; the passenger cars, with passage-ways through the entire length of the train, were nearest the locomotive, the box-car at the end. An experimental trip was made from St. Petersburg to Alexandrowsk, Adjutant

\* BILLROTH und MUNDY (*Über den Transport der im Felde Verwundeten und Kranken*, Wien, 1874, S. 108.) Professor BILLROTH seems to forget what will occur to most field-surgeons, that thick hair mattresses cannot always be procured when most urgently needed; and, further, that if skilled workmen with jack-screws and other tools were always in readiness, the alterations of the springs of 25 freight-cars would occupy many hours.

† BILLROTH (Th.) (*Chirurgische Briefe aus den Kriegs-Lazarethen* u. s. w. 1872, S. 71), says: "Frequently the press has urged that a large number of hospital cars should be held in readiness from the outset, to transport the wounded in the gentlest manner. That is well in theory; but, in practice, the cars will be scattered here and there when imperatively required for military purposes. To allow large numbers of empty cars to remain at depôts near the seat of conflict, until used for a special purpose, will only add to the perplexities of the railroad employes, who certainly have enough to do in complying with the orders of the military commanders. Most of the hospital trains that started for the seat of war during September with pompous announcements, returned without wounded, or with only slightly wounded and fever patients."

‡ From a communication in the *Deutsche Militärärztliche Zeitschrift*, 1873, B. II, p. 344.

General Count Heyden, several staff-officers, military surgeons and others from military and civil life participating.

The commission, after careful examination, arrived at the following conclusions. 1. "The transportation of the sick and wounded must be carried on mainly by the use of box-cars, as they form more than nine-tenths of all railway rolling stock. 2. Conversion of the cars to the purpose of transporting wounded at the shortest notice must be practicable, and preliminary measures must be undertaken in time of peace. 3. At the outbreak of hostilities, all appliances for the outfit of hospital cars must be immediately sent to points where it is anticipated that many wounded will be concentrated. 4. As a rule, litters are to be used for the transportation of the wounded; but, in cases of extreme necessity, a deep layer of straw on the bottom of the car, may be substituted."

"It was further observed that it was of the utmost importance that the box-cars to be used for the transport of severely wounded should have end-doors passage ways lengthwise, to permit easy intercommunication; and that, as the box-cars do not offer sufficient accommodation for very severely wounded, special sanitary trains should be formed of cars of classes 1, 2, and 3, and at once be forwarded to the seat of war. Box-cars without longitudinal passages may be used for slightly wounded, and it is recommended that in the making up of trains, passenger cars with the badly wounded, and all cars with end-doors be placed at the head of the train. The doors are to be widened, which may be accomplished by the construction of special doorways to be put together with an extra piece. Regarding the putting up of the litters, these experts decided that the system of vertical stanchions, to be provided in times of peace, would be the most serviceable, but that the cars should be so arranged as to admit of prompt alterations." The labor of this commission doubtless inspired the ingenious plan of railway transport for recumbent wounded patients devised by Mr. Zavodovsky which is the special object of this report.

Without submitting this system to the test of actual experiment, it would be, perhaps, unfair to definitively decide on its merits; but enough is known of the working of analogous systems to permit an approximative judgement to be formed. In Mr. Zavodovsky's plan litters are hung on ropes depending from swinging poles (Fig. 51, p. 51), which it is proposed to cut in the nearest forests. It may be objected to this mode of suspension, that it would be difficult to find a sufficient number of poles eight feet long and of suitable thickness and uniformity in strength. The elasticity would be anything but equable, the extremities of the poles necessarily yielding more than the middle portions. The numerous rope fastenings constitute another disadvantage; for it is proposed to leave the outfit to inexperienced hands, and there might well be insecurity in some one of the nine knots requisite for the suspension of each litter. The attachments to the floor appear very inadequate and insecure. In

the Hamburg hospital train (p. 37) arranged on a plan somewhat similar, but with a better method of suspension by spiral springs, and with the litters secured to the sides by C-springs, there was yet so much transverse swaying that the method was regarded at the Vienna Conference (p. 45) as very defective. It must be feared that the oscillation, both lateral and longitudinal, especially of the upper litter, would be still greater in cars arranged by the method of Mr. Zavodovsky. To meet emergencies, however, it is well to have familiarity with a variety of expedients, and to be thus enabled to utilize such material as may be available.

It is comparatively easy to transform the long passenger cars in general use in the United States into hospital cars for recumbent patients. It is only requisite to widen the end doors, to remove the alternate seats and the movable backs of those that remain, and to lay upon the latter field-stretchers on slats covered with bed-sacks. Thus 12 or 14 commodious litters can be promptly improvised in each car. But the main problem, of utilizing the railway conveyances most likely to be available near the battlefield, viz.: the box-cars of the supply trains, is not yet satisfactorily solved. It must never be forgotten that a plan applicable to the material on hand is much preferable to even better yet more complicated arrangements. It has been demonstrated that patients may be most comfortably transported by rail upon the Baden litters or the Gauvin spring-stretchers; but these appliances are too complex and costly ever to come into general use as field stretchers. In the present state of our knowledge it would appear that the simplest and best method for transforming freight-cars to hospital use is by the system of Mr. Grund (p. 39) as employed on some of the Prussian hospital trains and almost uniformly on those of Bavaria and the Palatinate. It would be necessary only to store in each freight-car 20 or 24 semi-elliptic springs (FIG. 49) and a sufficient number of spikes, to be enabled, with the aid of field stretchers, to improvise as many spring litters as the car could advantageously contain.

The foregoing cursory examination of the experience, discussions, and experimental trials of various nations regarding the railway transport of sick and wounded in war, indicates a very general solicitude for the determination of some regular system for this purpose during the leisure time of peace. When the hour of need comes, imperious exigencies allow little opportunity for reflection and experiment on the means best adapted to meet the requirements; little heed can be given to suggestions of pecuniary economy, and, unless provisions for their succor have been matured beforehand, the comfort of the disabled must be sacrificed to inexorable military necessities.

I am, General, very respectfully,

Your obedient servant,

GEORGE A. OTIS,

*Assistant Surgeon, U. S. Army.*

Surgeon General J. K. BARNES, U. S. Army.

## APPENDIX.

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NOTE A.—The official correspondence of which a minute is appended, led to the preparation of the foregoing report.

DEPARTMENT OF STATE,

Washington, 5th Decr., 1874.

The Honorable WM. W. BELKNAP,  
Secretary of War.

Sir:

I have the honor to enclose herewith, a copy of a despatch of the 16th of November ultimo, No. 47, from the Chargé d' Affaires *ad interim* of the United States at St. Petersburg relating to the transportation, by railway, of the sick and wounded in war.

The sealed letter addressed to you together with one copy of the pamphlet which accompanied the despatch are also enclosed.

I have the honor to be, Sir,

Your obedient servant,

(Signed) HAMILTON FISH.

The enclosed despatch was as follows:

LEGATION OF THE UNITED STATES,

St. PETERSBURG, November 16, 1874.

Sir:

I have the honor to enclose to you a sealed letter addressed to General Belknap, Secretary of War, and two copies of a pamphlet on the transportation of the sick and wounded in war. These have been given to me by Mr. A. Zavodovsky, the inventor of the special system which is treated of here.

The question of the transport of the wounded in war-time has been the subject of much study in Russia, and was carefully considered by a commission appointed by the Minister of War. The system perfected by Mr. Zavodovsky, as described in the accompanying pamphlet, was finally adopted.

Mr. Zavodovsky gives full permission to the government of the United States to adopt his invention, and asks for no recompense, but he would be glad to have the attention of the War Department especially called to it, and desires to learn the judgment that may be passed upon it.

I have the honor to be, Sir,

With the greatest respect,

Your very obedient servant,

(Signed) EUGENE SCHUYLER.

The Honorable HAMILTON FISH,  
Secretary of State.

The letter of Mr. Zavodovsky was as follows:

VOTRE EXCELLENCE!

Les malades et les blessés, transportés par voies ferrées en temps de guerre, réclament de grands ménagements, surtout ceux, qui ne pouvant se rendre d'eux mêmes à leur place, sont transportés à bras d'hommes.

En vue de toutes ces difficultés, j'ai projeté un appareil dans l'intérieur des wagons à marchandise, aussi simple que peu coûteux et parfaitement commode en route, pour les patients de cette catégorie.

Ce moyen de transport des blessés en temps de guerre, étant adopté pour l'armée Russe et celle des quelques pays de l'Europe, en remplacement de tous ce qui a été jusqu'à présent inventé dans ce genre, m'inspire un agréable désir, d'être utile à l'armée des Etats-Unis d'Amérique.

En Vous présentant ci-joint, la description de mon système de transport des blessés, je me compterais heureux si Votre Excellence, trouvera aussi ce système applicable, pour l'armée vaillante, confiée à Votre haute Administration.

Veuillez Votre Excellence, recevoir l'hommage du plus profond respect,

de

l'auteur

(Signed) A. ZAVODOVSKY.

St. Petersburg  
29 Octobre 1874,  
Rue Sérghievskia No. 13.

A translation of the explanatory pamphlet of Dr. ZAVODOVSKY is presented in NOTE B. The Secretary of War replied as follows:

WAR DEPARTMENT,

Washington, December 7, 1874.

To the Honorable,

THE SECRETARY OF STATE.

Sir:

I have the honor to acknowledge the receipt of your letter of the 5th instant, forwarding copy of a letter from the Chargé d' Affaires, *ad interim*, at St. Petersburg, with its enclosures, a sealed letter from Mr. A. Zavodovsky and two pamphlets elucidating his plan for transporting by railway sick and wounded in time of war, and to request the transmittal of the enclosed letter to M. Zavodovsky through the U. S. Legation at St. Petersburg.

Very respectfully,

Your obedient servant,

(Signed) WM. W. BELKNAP,

Secretary of War.

WAR DEPARTMENT,

WASHINGTON, December 7, 1874.

Sir:

I have the honor to acknowledge the receipt of your letter of October the 29th last, transmitting a pamphlet specifying and illustrating your system for the transportation of sick and wounded by railway, and to thank you for your marked kindness and courtesy.

The papers have been submitted to the Surgeon General of the Army for his views.

Very respectfully,

Your obedient servant,

(Signed) WM. W. BELKNAP,

Secretary of War.

Mr. A. ZAVODOVSKY,  
Rue Sérghievskia, No. 13,  
St. Petersburg, Russia.

NOTE B.—The following is a nearly literal translation of Mr. ZAVODOVSKY's report with wood-cut drawings reduced from the lithographed plates attached to that document:

"For the transportation of troops and war material by railway, the unengaged vehicles on the public lines are utilized.

Experience has demonstrated that, of the various conveyances making up the trains for the movement of large bodies of troops, of a hundred cars, nearly fifty freight-cars are requisite.

These latter are best suited to the transportation of the seriously wounded, who can only be moved in the recumbent position.

To adapt a freight-car to the purpose of transporting sick and wounded, it is necessary to have in view:

1. To mitigate the inevitable jolting due to the slight elasticity of springs of freight-cars.



2. To place the patients so as to avoid the contamination of the air by unwholesome emanations.
3. To arrange the wounded so that they may readily be accessible to the visits of the surgeon.
4. To secure such simplicity in the system that the soldiers and nurses may themselves be able to carry it out.
5. The economy of the said arrangement.

To satisfy all these conditions, it is proposed to place, in a freight-car, eight wounded men, of those injured in the trunk or lower limbs, attended by an infirmarian and one or two nurses, provided with surgical appliances and dressings (of the new sort invented by the Russian Dr. Wivodzéff) to render, if need be, immediate succor to the patients. The lifting into the car and transportation of the wounded is accomplished by means of stretchers, with poles of convenient length, that pass through the eyelets of the canvass sacking, and have attached an impermeable lining, left a little apart from the canvass, and designed to hold the blood and other discharges that might otherwise incommode the patient lying underneath.

Patients are placed in the freight-carriages in the following manner. Two robust men lift each stretcher, with the patient upon it, through the side door of the box car, and swing them, in order, to the upper, and then to the lower loops of the vertical cords. Having thus placed the patients, one above the other (See Fig. A), each pair of hammocks must be secured to the hooks screwed in three places to the floor of the car [z, z, z].

To unload the car, they begin by loosening the ropes that secure the stretchers to the floor, then the patient in the lowest hammock is moved, and then the one above him.

Freight-cars having very stiff springs, it is necessary to have some means of modifying the roughness of the transportation, which aggravates the sufferings of the wounded; but such means must be of the simplest possible description.

To remedy this serious objection, and to preserve the patients from all shocks from the motion of the trains, four cables A, A., an inch in thickness, are suspended across the top of the car, and secured to iron hooks, that fasten to iron rings two and a half inches below the roof of the car. If hooks and rings are not available, the ropes may be passed through eight holes bored in the side of the car. To each of the four ropes is attached, at three points (Fig. A, b, b, b) a pole of oak, birch, elm, ash, or other springy wood (B, B,) adapted to the width of the car, but at least eight feet long, and two and a half inches thick in the middle, an inch and three quarters at the ends. To the poles, thus placed horizontally, there are attached, on either side, four cords (Fig. A, c, c, c, c) with knots (x, x, x, x) so arranged that they may support on a level the stretchers (D, D) on which the wounded men are supposed to be reclining.

In order that, when the car is in motion, the stretchers with the patients may not sway back and forth, and strike against the sides of the car, the lower stretchers are fastened by inch and a half ropes to three small iron hooks (z, z, z) screwed into the floor of the conveyance.

Between the doors, a bracket seat is placed for the nurses.

A vehicle of this description has been submitted to the most careful scrutiny of experts, who had served in the later wars in Prussia, Austria and Italy; and they have unanimously verified the fact, that, apart from the simple and practical nature of its preparation, it provides the patients in journeying with an equable and comfortable transportation.

The arrangements will readily be understood on consulting the figures A and B.

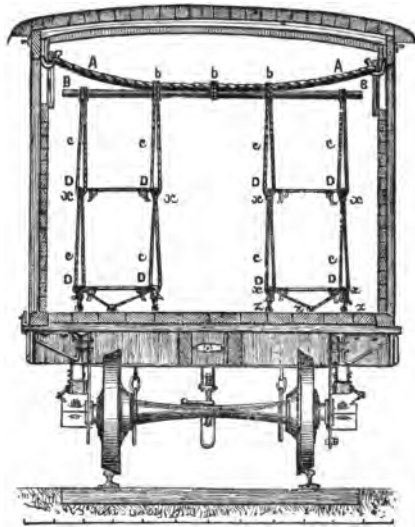


FIG. A.—Transverse Section of a freight-car, with stretchers suspended in it. [Reduced to one-third from Dr. Zavodovsky's drawing.]

The expense required to adapt this system to a freight-car (*wagon à marchandises*) with all

the necessary materials apart from the stretchers, is not more than seventeen, or, at the outside, twenty dollars, and offers, moreover, the great advantage that it can be removed almost instantaneously, or else swung under the roof of the car, leaving the interior as it were free for the transportation of horses, or arms, or troops, or munitions and stores of whatever character the exigences of war may require.

Usually such cars, the supplies having been delivered, come empty from the battlefield; but with this system it is easy in less than two minutes to arrange the ropes, and to receive the wounded brought in on stretchers, and to convey them to hospitals or to their homes.

Each car containing patients should be provided with a flag to inform the medical officer when his presence is needed.

The signal indicates an urgent case, and that the train must stop, that the patient may at once have assistance of a surgeon.

The cost of fitting up the box-car may be reduced to six dollars even ("30 francs") provided that instead of securing the four large transverse cables by iron hooks and

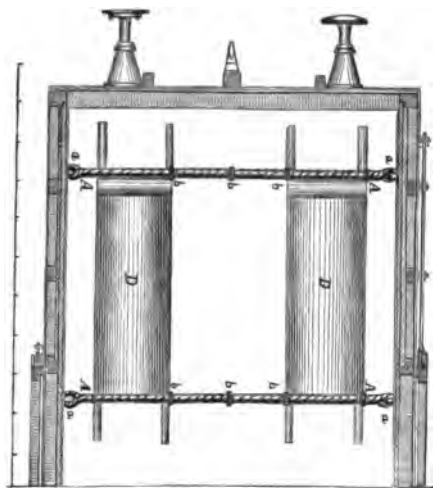


FIG. B.—Horizontal view of the outfit for the wounded in a freight car shown vertically in FIG. A.

rings, they are passed through holes bored near the roof of the car, and knotted outside.

The poles of tough elastic wood, such as oak, birch, or others, may be cut from the forests near by; instead of hooks on the floor of the car, common nails will answer, and the work can be done by the nurses who accompany the patients.

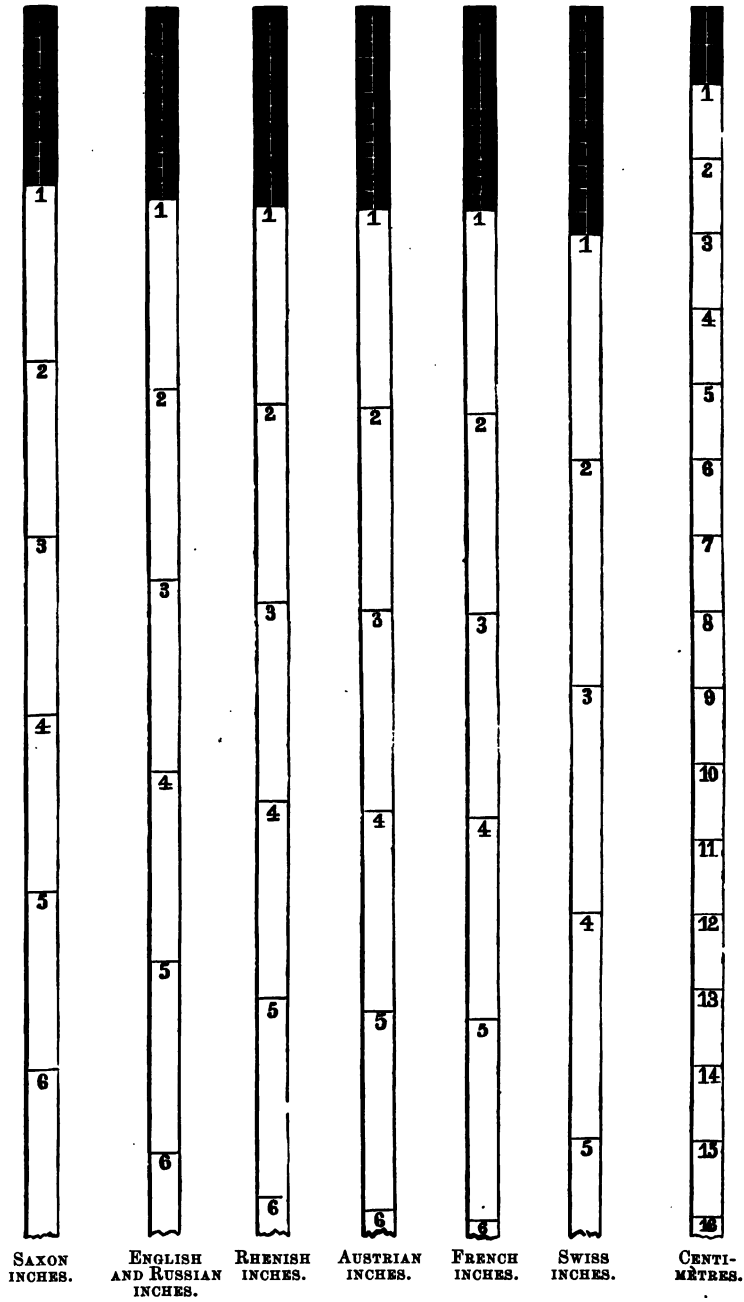
To fit up such freight-cars, much less costly materials are used than caoutchouc, leather girths and straps, metallic springs, etc., which, after all, do not possess the solidity that is desirable.

Suitable wood and ropes can be found almost everywhere; and the simplicity of this system permits those who have charge of the sick and wounded to prepare, in a very short time, a freight-car for the transportation of eight patients.

No great expenditure is requisite to have, in war-time, a reserve supply of poles and rope. The time required to put an army in the field, amply suffices for the preparation of the necessary transportation.

Russia and some other European Countries, recognizing the utility of this system, as being the simplest and most practical hitherto suggested, have introduced in their armies this method of railway transportation for the sick and wounded."

NOTE C.—Such a variety of measures of length have been employed in the description of the railway cars and litters in use by different nations, that it will be convenient to imitate Professor Gurlt in annexing a scale of the principal subdivisions of the foot adopted by various nations, and of the French metre. These are shown on the diagram opposite.



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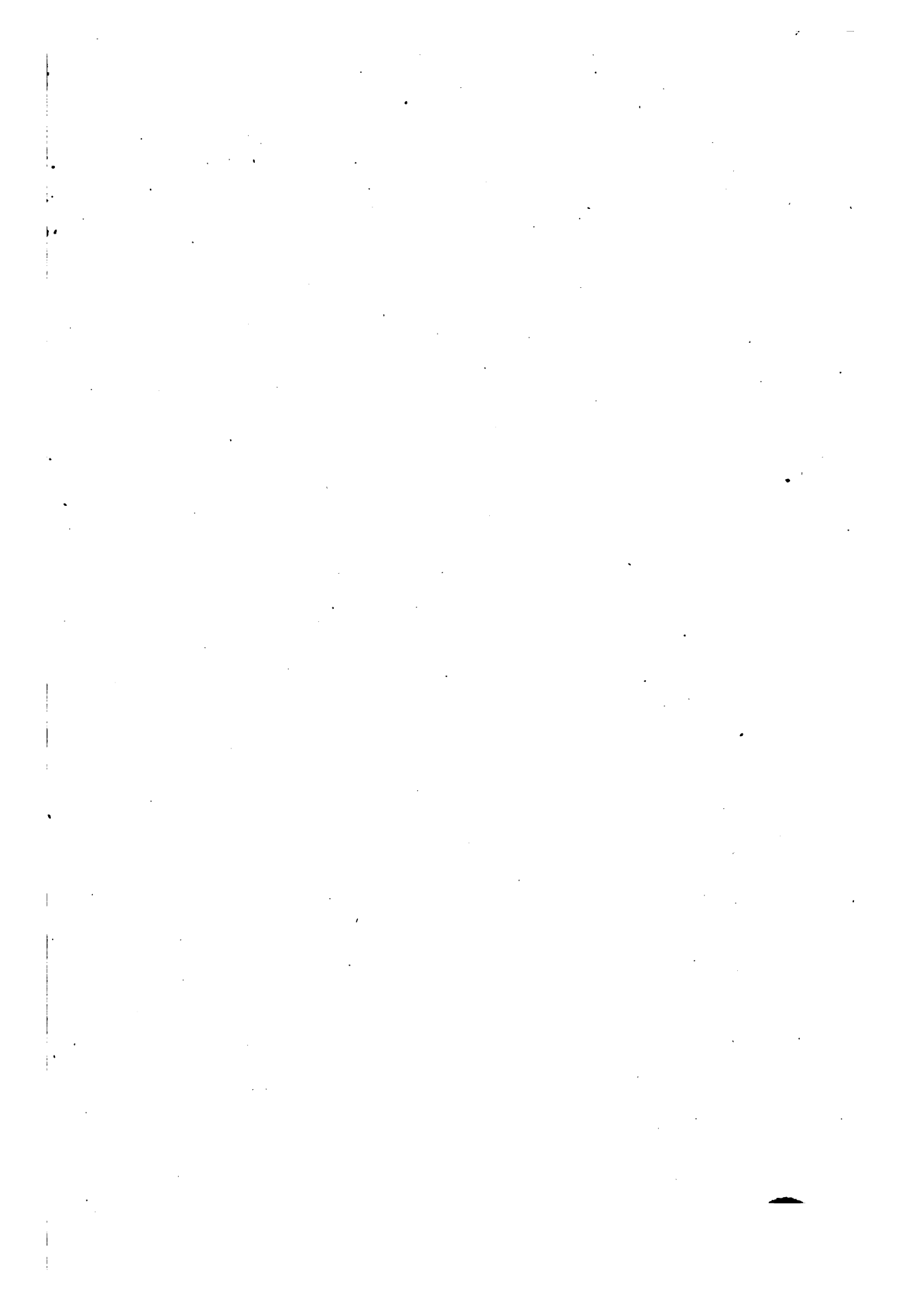
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#### ERRATA.

Page 39, line 9, for "Montigany," read Montigny.

Page 47, line 32, for "judgement," read judgment.







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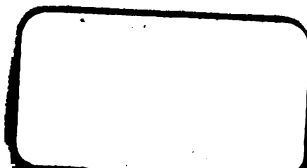
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